1962
ASME
BOILER
AND
PRESSURE
VESSEL
CODE

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ASME BOILER AND PRESSURE VESSEL CODE

MATERIAL SPECIFICATIONS

section II

1962

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MATERIAL SPECIFICATIONS

1962 EDITION

REPORT OF SUBCOMMITTEE OF BOILER AND PRESSURE
VESSEL COMMITTEE ON MATERIALS

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS
UNITED ENGINEERING CENTER
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1962 ASME Boiler and Pressure Vessel Code

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IV	LOW-PRESSURE HEATING BOILERS
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Case Interpretations

The Boiler and Pressure Vessel Committee meets regularly to consider requests for interpretations of the Code and to consider rulings for conditions encountered requiring special provisions. Those which have been adopted are published in a case interpretation booklet. In addition that booklet contains a separate group of SPECIAL RULINGS COVERING NUCLEAR INSTALLATIONS.

Interpretation and Addenda Service

Pink Sheet Addenda, which include additions to and revisions of all existing sections of the Code, and subsequent case interpretations in white loose leaf sheets may be obtained from the ASME Publication Sales Department at an annual subscription price.

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Approved by Council, The American Society of Mechanical Engineers, January 3, 1962, and previously

Foreword

The American Society of Mechanical Engineers set up a committee in 1911 for the purpose of formulating standard rules for the construction of steam boilers and other pressure vessels. This committee is now called the Boiler and Pressure Vessel Committee.

The Committee's function is to establish rules of safety governing the design, the fabrication, and the inspection during construction of boilers and unfired pressure vessels, and to interpret these rules when questions arise regarding their intent. In formulating the rules, the Committee considers the needs of users, manufacturers, and inspectors of pressure vessels. The objective of the rules is to afford reasonably certain protection of life and property and to provide a margin for deterioration in service so as to give a reasonably long safe period of usefulness. Advancements in design and material, and the evidence of experience have been recognized.

The Boiler and Pressure Vessel Committee deals with the care and inspection of boilers and pressure vessels in service only to the extent of providing suggested rules of good practice as an aid to owners and their inspectors.

The rules established by the Committee are not to be interpreted as approving, recommending, or endorsing any proprietary or specific design or as limiting in any way the manufacturer's freedom to choose any method of design or any form of construction that conforms to the Code rules.

The Boiler and Pressure Vessel Committee meets regularly to consider requests for interpretations and revisions of the rules. Inquiries must be in writing and must give full particulars in order to receive consideration. Requests for interpretations which are of a routine nature may be executed by the Secretary of the Boiler and Pressure Vessel Committee without reference to a subcommittee. All other requests are first referred to the proper subcommittee for consideration and for recommendation of action by the Main Committee. The action of the Main Committee becomes effective only after confirmation by letter ballot of the Committee and approval by the Council of the Society.

Interpretations of general interest are published in *Mechanical Engineering* as Code Cases, and inquirers are advised of the action taken. Code revisions approved by the Committee are published in *Mechanical Engineering* as proposed addenda to the Code to invite comments from all interested persons. After final approval by the Committee and adoption by the ASME Council, they are printed in the addenda supplements to the Code.

Code Cases (interpretations) may be used in the construction of vessels to be stamped with the ASME Code symbol beginning with the date of their approval by the ASME Council.

After Code revisions are approved by council they may be used beginning with the date of issuance shown on the pink sheet addenda. Revisions become mandatory as minimum requirements six months after such date of issuance, except for boilers or pressure vessels contracted for prior to the end of the six-month period.

Manufacturers and users of pressure vessels are cautioned against making use of revisions and Cases that are less restrictive than former requirements without having assurance that they have been accepted by the proper authorities in the jurisdiction where the vessel is to be installed.

Each state and municipality in the United States and each province in the Dominion of Canada that adopts or accepts one or more Sections of the Boiler and Pressure Vessel Code is invited to appoint a representative to act on the Conference Committee to the Boiler and Pressure Vessel Committee. Since the members of the Conference Committee are in active contact with the administration and enforcement of the rules, the requirements for inspection in this Code correspond with those in effect in their respective jurisdictions. The required qualifications for an authorized inspector under these rules may be obtained from the administrative authority of any state, municipality, or province which has adopted these rules.

The Boiler and Pressure Vessel Committee in the formulation of its rules and in the establishment of maximum design and operating pressures considers materials, construction, method of fabrication, inspection, and safety devices. Permission may be granted to regulatory bodies and organizations publishing safety standards to use a complete Section of the Code by reference. If

usage of a Section, such as Section I, involves exceptions, omissions, or changes in provisions, the intent of the Code might not be attained.

Where a state or other regulatory body, in the printing of any Section of the ASME Boiler and Pressure Vessel Code, makes additions or omissions, it is recommended that such changes be clearly indicated.

The National Board of Boiler and Pressure Vessel Inspectors is composed of chief inspectors of states and municipalities in the United States and of provinces in the Dominion of Canada that have adopted the Boiler and Pressure Vessel Code. This Board, since its organization in 1919, has functioned to uniformly administer and enforce the rules of the Boiler and Pressure Vessel Code. The cooperation of that organization with the Boiler and Pressure Vessel Committee has been extremely helpful. Its function is clearly recognized and, as a result, inquiries received which bear on the administration or application of the rules are referred directly to the National Board. Such handling of this type of inquiry not only simplifies the work of the Boiler and Pressure Vessel Committee, but action on the problem for the inquirer is thereby expedited. Where an inquiry is not clearly an interpretation of the rules, nor a problem of application or administration, it may be considered both by the Boiler and Pressure Vessel Committee and the National Board.

It should be pointed out that the state or municipality where the Boiler and Pressure Vessel Code has been made effective has definite jurisdiction over any particular installation. Inquiries dealing with problems of local character should be directed to the proper authority of such state or municipality. Such authority may, if there is any question or doubt as to the proper interpretation, refer the question to the Boiler and Pressure Vessel Committee.

The specifications for materials given in Section II of the Code are identical with or similar to those of the American Society for Testing Materials as indicated, except in those cases where that organization has no corresponding specification.

Statement of Policy on Use of Code Symbols in Advertising

The American Society of Mechanical Engineers established a series of symbols, for the marking of boilers, pressure vessels, and certain appurtenances which have been constructed and inspected in compliance with the ASME Boiler and Pressure Vessel Code. It is the aim of the Society to maintain the standing of the Code Symbols for the benefit of the users, the enforcement jurisdictions, and the holders of the symbols who comply with all requirements. Based on that objective the following policy has been established on the usage in advertising of facsimiles of the symbols and reference to Code construction.

The American Society of Mechanical Engineers does not "approve," "certify," "endorse" or "rate" any product or construction and there shall be no statements or inferences which might so indicate. A manufacturer holding a Code Symbol and a Certificate of Authorization may state in advertising literature that its products "are built in accordance with the requirements of the ASME Boiler and Pressure Vessel Code," or "meet the requirements of the ASME Boiler and Pressure Vessel Code."

The ASME Symbol shall be used only for stamping and name plates as specifically provided in the Code. However, facsimiles may be used for the purpose of fostering the use of such construction. Such usage may be by an association or a society, or by a holder of a Code Symbol who may also use the facsimile in advertising to show that clearly specified products will carry the symbol. General usage is permitted only when *all* of a manufacturer's products are constructed under the Rules.

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ASME BOILER and PRESSURE VESSEL CODE

SECTION II

MATERIAL SPECIFICATIONS

FERROUS MATERIALS

SPECIFICATION FOR STEEL FOR BRIDGES AND BUILDINGS

SA-7

(IDENTICAL WITH ASTM SPECIFICATION A 7-61T EXCEPT THAT THE REFERENCES TO BESSEMER STEEL HAVE BEEN DELETED)

Scope

1. This specification covers carbon-steel shapes, plates, and bars of structural quality for use in the construction of bridges and buildings and for general structural purposes.

Appurtenant Materials

2. Unless otherwise provided in the order, the current edition of the ASTM specifications listed in Table I shall govern the delivery of the respective appurtenant materials when included with material purchased under the ASTM Designation A 7.

General Requirements for Delivery

3. Material furnished under this specification shall conform to the applicable requirements of the current edition of the Specification for General Requirements for Delivery of Rolled Steel Plates, Shapes, Sheet Piling, and Bars for Structural Use (ASTM Designation: A 6).

Bearing Plates and Anchor Bolts

4. (*a*) Unless otherwise specified, plates used as bearing plates for bridges shall be subjected to mechanical tests and shall conform to the tensile requirements of Section 7.

TABLE I.

Material	ASTM Designation[a]
Rivet Steel	A 141
Bolts and Nuts	A 307, A 325
Cast Iron	A 48, Class 25
Malleable Iron	A 47, Grade No. 35018
Cast Steel	A 27, Grade 65-35 full annealed, with minimum yield point of 33,000 psi
Forgings (Carbon Steel)	A 235, Class C1
Hot-Rolled Sheets	A 245, Grade C
Hot-Rolled Strip	A 303, Grade C

[a] These designations refer to the following specifications:
Specification for Structural Rivet Steel (ASTM Designation: A 141),
Specifications for Low Carbon Steel Externally and Internally Threaded Standard Fastener (ASTM Designation: A 307),
Specifications for Quenched and Tempered Steel Bolts and Studs with Suitable Nuts and Plain Hardened Washers (ASTM Designation: A 325),
Specifications for Gray Iron Castings (ASTM Designation: A 48),
Specifications for Malleable Iron Castings (ASTM Designation: A 47),
Specifications for Mild- to Medium-Strength Carbon-Steel Castings for General Application (ASTM Designation: A 27),
Specification for Carbon Steel Forgings for General Industrial Use (ASTM Designation: A 235),
Specifications for Flat-Rolled Carbon Steel Sheets of Structural Quality (ASTM Designation: A 245), and
Specifications for Hot-Rolled Carbon Steel Strip of Structural Quality (ASTM Designation: A 303).

(*b*) Unless otherwise specified, mechanical tests shall not be required for plates over 1½ in. in thickness used as bearing plates in buildings and for general structural purposes, subject to the requirement that they shall be open hearth, basic oxygen, or electric furnace steel containing 0.20 to 0.33 per cent carbon by ladle analysis, that the chemical composition shall conform to the requirements of Section 6, and that a sufficient discard shall be made from each ingot to secure sound plates.

(*c*) Unless otherwise specified, all plain and threaded bars used for anchorage purposes shall be subjected to mechanical tests and shall confom to the tensile requirements of Section 7; headed bolts used for anchorage purposes, and all nuts, shall conform to the requirements of Specification A 307.

Process

5. The steel, shall be made by one or more of the following processes: open hearth, basic oxygen, or electric furnace.

Chemical Composition

6. (*a*) When subjected to the ladle and check analyses, respectively, required by

TABLE II.—CHEMICAL REQUIREMENTS.

	Ladle Analysis	Check Analysis
Phosphorus, max, per cent:		
Open hearth, basic oxygen, or electric furnace:		
Acid	0.06	0.075
Basic	0.04	0.05
Sulfur, max, per cent (open hearth, basic oxygen, or electric furnace)	0.05	0.063
Copper, when copper steel is specified, min, per cent	0.20	0.18

TABLE III.—TENSILE REQUIREMENTS.

	Plates, Shapes, and Bars
Tensile strength, psi:	
For shapes of all thicknesses	60 000 to 75 000
For plates and bars up to 1½ in., incl in thickness	60 000 to 72 000
For plates and bars over 1½ in. in thickness	60 000 to 75 000
Yield point, min, psi	33 000
Elongation in 8 in., min, per cent	21[a]
Elongation in 2 in., min, per cent	24[b]

[a] See Section 7(c) and (d).
[b] See Section 7(e).

TABLE IV.—BEND TEST REQUIREMENTS.

Thickness of Material, in.	Ratio of Bend Diameter to Thickness of Specimen for Plates, Shapes, and Bars
¾ and under	½
Over ¾ to 1, incl	1
Over 1 to 1½, incl	1½
Over 1½ to 2, incl	2½
Over 2 in.	3

the provisions of Specification A 6, the steel shall conform to the requirements as to chemical composition prescribed in Table II, except as specified in Paragraph (*b*) of this section.

(*b*) Check analysis is not required for bar-size shapes, for flat bars ½ in. and under in thickness, or for any bars ordered as merchant quality.

(*c*) When tension tests are waived in accordance with Section 7 (*b*), chemistry consistent with the mechanical properties desired must be applied.

Tensile Properties

7. (*a*) The material as represented by the test specimens, except as specified in Section 4 and Paragraph (*b*) of this section, shall conform to the requirements as to tensile properties prescribed in Table III.

(*b*) Shapes less than 1 sq in. in cross-section, and bars, other than flats, less than ½ in. in thickness or diameter need not be subjected to tension tests by the manufacturer.

(*c*) For material under $\frac{5}{16}$ in. in thickness or diameter, a deduction from the percentage of elongation in 8 in. specified in Table III of 1.25 per cent shall be made for each decrease of $\frac{1}{32}$ in of the specified thickness or diameter below $\frac{5}{16}$ in.

(*d*) For material over ¾ in. in thickness or diameter, a deduction from the percentage of elongation in 8 in. specified in Table III of 0.50 per cent shall be made for each increase of ¼ in. of the specified thickness or diameter above ¾ in. This deduction shall not exceed 3 per cent.

(*e*) For material over 3½ in. in thickness or diameter, a deduction from the percentage of elongation in 2 in. specified in Table III of 0.50 per cent shall be made for each increase of ½ in. of the specified thickness or diameter above 3½ in. This deduction shall not exceed 3 per cent.

Bending Properties

8. The bend test specimen shall stand being bent cold through 180 deg without cracking on the outside of the bent portion to an inside diameter which shall have a relation to the thickness of the specimen as prescribed in Table IV.

Number of Tests

9. Two tension and two bend tests shall be made from each heat unless the finished material from a heat is less than 30 tons when one tension test and one bend test will be sufficient. If, however, material from one heat differs ⅜ in. or more in thickness, one tension test and one bend test shall be made from both the thickest and the thinnest material rolled, regardless of the weight represented.

SPECIFICATION FOR BOILER AND FIREBOX STEEL FOR LOCOMOTIVES

SA-30

(IDENTICAL WITH ASTM SPECIFICATION A 30-56)

Scope

1. This specification covers steel plates up to 2 in., inclusive, in thickness; of flange and firebox qualities; for boilers for locomotives.

General Conditions for Delivery

2. Material furnished under this specification shall conform to the applicable requirements of the current edition of the Tentative Specification for General Requirements for Delivery of Rolled Steel Plates of Flange and Firebox Qualities (ASTM Designation: A 20).

Process

3. The steel shall be made by either or both of the following processes: open-hearth or electric-furnace.

Chemical Composition

4. The steel shall conform to the requirements as to chemical composition prescribed in Table I.

Tensile Properties

5. (*a*) The material as represented by the tension test specimen shall conform to the requirements as to tensile properties prescribed in Table II.

(*b*) On the tension test specimen taken from the top of firebox plates, tensile strength only is to be determined, and it shall not exceed 70,000 psi. for grade A, nor 63,000 for grade B.

(*c*) For material under $\frac{5}{16}$ in. in thickness, a deduction from the percentage of elongation in 8 in. specified in Table II of 1.25 per cent shall be made for each decrease of $\frac{1}{32}$ in. of the specified thickness below $\frac{5}{16}$ in.

(*d*) For material over ¾ in. in thickness, a deduction from the percentage of elongation in 8 in. specified in Table II of 0.5 per cent shall be made for each increase of ⅛ in. of the specified thickness above ¾ in. This deduction shall not exceed 3 per cent.

TABLE I.—CHEMICAL REQUIREMENTS.

	Flange	Firebox
Carbon, max., per cent:		
For plates ½ in. or under in thickness	[a]	0.25
For plates over ½ in. in thickness	[a]	0.30
Manganese, per cent:		
For plates ½ in. or under in thickness	0.30 to 0.80	0.30 to 0.80
For plates over ½ in. in thickness	0.30 to 0.80	0.30 to 0.80
Phosphorus, max., per cent:		
Acid	0.05	0.04
Basic	0.04	0.035
Sulfur, max., per cent	0.05	0.04
Incidental copper, max., per cent		0.25

[a] The required mechanical properties and current mill practice normally result in the carbon content not exceeding 0.35 per cent. However, determination of this element or certification that this limit is complied with shall be made only when specified in the inquiry and contract or order.

Bending Properties

6. The bend test specimen shall stand being bent cold through 180 deg, without cracking on the outside of the bent portion to an inside diameter which shall have the following relation to the thickness of the specimen:

Thickness of Material, in.	Ratio of Bend Diameter to Thickness of Specimen
1 and under	1
Over 1	2

Test Specimens

7. (*a*) Test specimens shall be prepared for testing from material in its rolled condition.

(*b*) When so specified in the purchase order with the mill, test specimens representing the plates shall be stress-relieved by gradually and uniformly heating them to a temperature between 1100 and 1200 F. (or a temperature range otherwise agreed upon between the manufacturer and the fabricator), holding at temperature for at least 1 hr. per inch of thickness and cooling in still atmosphere to a temperature not exceeding 600 F.

Number of Tests

8. Two tension tests, one bend test and one homogeneity test shall be made from each firebox steel plate as rolled. One tension test and one bend test shall be made from each flange steel plate as rolled.

NOTE.—The term "plate as rolled" used here refers to the unit plate rolled from a slab or directly from an ingot in its relation to the location and number of specimens; not to its condition.

TABLE II.—TENSILE REQUIREMENTS.

	Flange	Firebox	
		Grade A	Grade B
Tensile strength, psi	55 000 to 65 000	55 000 to 65 000	48 000 to 58 000
Yield point, min, psi	30 000	30 000	26 000
Elongation in 8 in., min, per cent	24[a]	25[a]	27[a]
Elongation in 2 in., min, per cent	28	29	30

[a] See Section 5 (*c*) and (*d*).

SPECIFICATION FOR BOILER RIVET STEEL AND RIVETS

SA-31

(IDENTICAL WITH ASTM SPECIFICATION A 31-55)

Scope

1. These specifications cover two grades of rivet steel and rivets to be used in boilers and other pressure vessels.

Requirements for Rolled Bars

Process

2. The steel shall be made by either or both of the following processes: open-hearth or electric-furnace.

Chemical Composition

3. The steel shall conform to the requirements as to chemical composition prescribed in Table I.

Ladle Analysis

4. An analysis of each heat of steel shall be made by the manufacturer to determine for grades A and B the percentages of carbon, manganese, phosphorus, and sulfur. This analysis shall be made from a test ingot taken during the pouring of the heat. The chemical composition thus determined shall be reported to the purchaser or his representative and shall conform to the requirements for ladle analysis prescribed in Table I.

Check Analysis

5. An analysis may be made by the purchaser from finished bars representing each heat. The chemical composition thus determined shall conform to the requirements for check analysis prescribed in Table I.

Tensile Properties

6. (*a*) The material shall conform to the requirements as to tensile properties prescribed in Table II.

(*b*) The yield point shall be determined by the drop of the beam or halt in the gage of the testing machine.

Bending Properties

7. (*a*) The test specimen for grade A steel shall stand being bent cold through 180 deg flat on itself without cracking on the outside of the bent portion.

(*b*) The test specimen for grade B steel shall stand being bent cold through 180 deg without cracking on the outside of the bent portion to an inside diameter which shall have a relation to the diameter of the specimen as prescribed in Table III.

Test Specimens

8. (*a*) Test specimens shall be the full diameter of the bars as rolled.

(*b*) Tension and bend test specimens for rivet bars which have been cold-drawn shall be normalized before testing.

TABLE I.—CHEMICAL REQUIREMENTS.

	Grade A		Grade B	
	Ladle Analysis	Check Analysis	Ladle Analysis	Check Analysis
Carbon, max, per cent	...	...	0.28	0.31
Manganese, per cent	0.30 to 0.60	0.27 to 0.63	0.30 to 0.80	0.27 to 0.83
Phosphorus, max, per cent	0.040	0.048	0.040	0.048
Sulfur, max, per cent	0.050	0.058	0.050	0.058

Number of Tests

9. (*a*) Two tension and two bend tests shall be made from each heat, unless the finished material from a heat is less than 30 tons, when one tension test and one bend test will be sufficient. Each test shall conform to the requirements specified in Sections 6 and 7.

(*b*) If any test specimen develops flaws, it may be discarded and another specimen substituted.

(*c*) If the percentage of elongation of any tension test specimen is less than that specified in Section 6(*a*) and any part of the fracture is outside the middle third of the gage length, as indicated by scribe scratches marked on the specimen before testing, a retest shall be allowed.

Permissible Variations in Diameter

10. The diameter of hot-finished rivet bars shall not vary from the size specified by more than the amounts prescribed in Table IV.

Finish

11. The material shall be free from injurious defects.

Marking

12. The rivet bars shall, when loaded for shipment, be properly separated in lifts and tagged with the name or brand

TABLE II.—TENSILE PROPERTIES.

	Grade A	Grade B
Tensile strength, psi	45 000 to 55 000	58 000 to 68 000
Yield point, min, psi	23 000	29 000
Elongation in 8 in., min, per cent	27	22

TABLE III.—BEND REQUIREMENTS.

Specimen Diameter, in.	Ratio of Bend Diameter to Diameter of Specimen
¾ and under	½
Over ¾	1

of the manufacturer and the heat number for identification. The heat number shall be legibly marked on each test specimen.

Inspection

13. The inspector representing the purchaser shall have free entry, at all times while work on the contract of the purchaser is being performed, to all parts

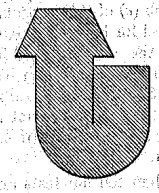


FIG. 1.—Bend Test of Rivet.

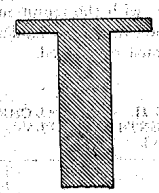


FIG. 2.—Flattening Test of Rivet.

of the manufacturer's works which concern the manufacture of the material ordered. The manufacturer shall afford the inspector, without charge, all reasonable facilities to satisfy him that the material is being furnished in accordance with these specifications. All tests (except check analysis for bars) and inspection shall be made at the place of manufacture prior to shipment, unless otherwise specified, and shall be so conducted as not to interfere unnecessarily with the operation of the works.

Requirements for Rivets

Bending Properties

14. (*a*) The rivet shank of grade A steel shall stand being bent cold through 180 deg flat on itself, as shown in Fig. 1, without cracking on the outside of the bent portion as prescribed in Table V.

(*b*) The rivet shank of grade B steel shall stand being bent cold through 180 deg without cracking on the outside of

TABLE IV.—PERMISSIBLE VARIATIONS IN THE SIZE OF HOT-ROLLED ROUNDS.

Specified Size, in.	Variations from Size, in.		Out-of-Round, in.
	Over	Under	
⅝ and under	0.005	0.005	0.008
Over ⅝ to 7/16, incl	0.006	0.006	0.009
Over 7/16 to ⅝, incl	0.007	0.007	0.010
Over ⅝ to ⅞, incl	0.008	0.008	0.012
Over ⅞ to 1, incl	0.009	0.009	0.013
Over 1 to 1⅛, incl	0.010	0.010	0.015
Over 1⅛ to 1¼, inc	0.011	0.011	0.016
Over 1¼ to 1⅜, incl	0.012	0.012	0.018
Over 1⅜ to 1½, incl	0.014	0.014	0.021

NOTE.—Out-of-round is the difference between the maximum and minimum diameters of the bar, measured at the same cross-section.

Flattening Tests

15. The rivet head shall stand being flattened, while hot, to a diameter 2½ times the diameter of the shank, as shown in Fig. 2, without cracking at the edges.

Number of Tests

16. Three bend and three flattening tests shall be made from each size in each lot of rivets offered for inspection. Each test shall conform to the requirements specified in Sections 14 and 15.

Permissible Variations in Diameter

17. (*a*) *Finished Rivets.*—The diameter of finished rivets, measured cold, shall not vary from the size specified by more than the amounts prescribed in Table VI.

(*b*) Snap gage measurement shall be made at the point of minimum diameter, but it is not required that the rivet shall turn completely in the gage. Measurements of the maximum tolerance shall

TABLE V.—BEND REQUIREMENTS.

Diameter of Rivet Shank, in.	Ratio of Bend Diameter to Diameter of Rivet Shank
¾ in. and under	1
Over ¾ in.	1¼

TABLE VI.—PERMISSIBLE VARIATIONS IN DIAMETER.

Diameter Specified, in.	Permissible Variations in Diameter, in.	
	Snap Gage Measurement	Ring Gage Measurement
½ in. and under	0.022 under	0.020 over
Over ½ to 1, incl	0.025 under	0.030 over
Over 1 to 1¼, incl	0.027 under	0.035 over
Over 1¼ to 1½, incl	0.030 under	0.040 over

be made with a ring gage, all rivets to slip full to the head in the gage of the required size for the various diameters.

(*c*) *Rivet Heads.*—The dimensions of the rivet heads shall not vary from the size specified by more than the amounts prescribed in Table VII.

Workmanship and Finish

18. The finished rivets shall be true to form and concentric and shall be free from injurious defects.

Rejection

19. (*a*) Unless otherwise specified, any rejection based on tests made in accordance with Section 5 shall be reported to the manufacturer within five working days from the receipt of samples by the purchaser.

(*b*) Material that shows injurious defects subsequent to its acceptance at the manufacturer's works will be rejected, and the manufacturer shall be notified.

Rehearing

20. Samples tested in accordance with Section 5 that represent rejected material shall be preserved for two weeks from the date of the test report. In case of dissatisfaction with the results of the tests, the manufacturer may make claim for a rehearing within that time.

TABLE VII.—PERMISSIBLE VARIATIONS IN RIVET HEADS.

Specified Size of Rivets, in.	Permissible Variations in Dimensions of Head, in.	
	Diameter	Height
½	+1/16 −1/32	+1/32
9/16	+1/16 −1/32	+1/32
⅝	+1/16 −1/32	+1/32
11/16	+1/16 −1/32	+1/32
¾	+1/64 −1/32	+1/32
⅞	+1/64 −1/32	+1/32
1	+1/64 −1/32	+1/32

SPECIFICATION FOR STRUCTURAL STEEL

SA-36

(IDENTICAL WITH ASTM SPECIFICATION A 36-61T)

Scope

1. This specification covers carbon steel shapes, plates, and bars of structural quality not over 4 in. in thickness for use in riveted, bolted, or welded construction of bridges and buildings, and for general structural purposes. When the steel is used for welded construction, it is important that suitable welding procedures be used.

Appurtenant Materials

2. Unless otherwise provided in the order, the current edition of the ASTM specifications listed in Table I shall govern the delivery of the respective appurtenant materials when included with material purchased under the ASTM Designation A 36.

General Requirements for Delivery

3. Material furnished under this specification shall conform to the applicable requirements of the current edition of the Specification for General Requirements for Delivery of Rolled Steel Plates, Shapes, Sheet Piling, and Bars for Structural Use (ASTM Designation: A 6).

Anchor Bolts

4. Unless otherwise specified, all plain and threaded bars used for anchorage purposes shall be subjected to mechanical tests and shall conform to the tensile requirements of Section 7; headed bolts used for anchorage purposes, and all nuts, shall conform to the requirements of Specification A 307.

Process

5. The steel shall be made by one or more of the following processes: open hearth, basic oxygen, or electric furnace.

Chemical Composition

6. (*a*) When subjected to the ladle and check analysis, respectively, required by the provisions of Specification A 6, the steel shall conform to the applicable requirements for chemical composition prescribed in Table II, except as specified in Paragraph (*c*) of this Section.

(*b*) Steel for plates and bars shall conform to the requirements for chemical composition prescribed in Table III, in addition to those prescribed in Table II.

(*c*) Check analysis is not required for bar-size shapes or flat bars ½ in. and under in thickness.

(*d*) When tension tests are waived in accordance with Section 7(*b*), chemistry consistent with the requirements in Table II, and with the mechanical properties desired must be applied.

TABLE I.—MATERIAL SPECIFICATIONS.

Material	ASTM Designation[a]
Rivet Steel	A 141
Bolts and Nuts	A 307, A 325
Cast Iron	A 48, (Appropriate Class
Malleable Iron	A 47, Grade No. 35018
Cast Steel	A 27, Grade 65–35
Forgings (Carbon Steel)	A 235, Class C1
Hot-Rolled Sheets	A 245, Grade C
Hot-Rolled Strip	A 303, Grade C

[a] These designations refer to the following Specifications of the American Society for Testing Materials:
A 141, Structural Rivet Steel,
A 307, Low Carbon Steel Externally and Internally Threaded Standard Fastener,
A 325, Quenched and Tempered Steel Bolts and Studs with Suitable Nuts and Plain Hardened Washers,
A 48, Gray Iron Castings,
A 47, Malleable Iron Castings,
A 27, Mild- to Medium-Strength Carbon-Steel Castings for General Application,
A 235, Carbon Steel Forgings for General Industrial Use,
A 245, Flat-Rolled Carbon Steel Sheets of Structural Quality,
A 303, Hot Rolled Carbon Steel Strip of Structural Quality.

TABLE II.—GENERAL CHEMICAL REQUIREMENTS FOR PLATES, SHAPES, AND BARS.

	Ladle Analysis	Check Analysis
Carbon, max, per cent	0.28	0.32
Phosphorus, max, per cent	0.04	0.05
Sulfur, max, per cent	0.05	0.063
Copper, when copper steel is specified, min, per cent	0.20	0.18

TABLE III.—ADDITIONAL CHEMICAL REQUIREMENTS FOR PLATES AND BARS.

Product	Plates				Bars	
Thickness	Over ¾ to 1½ in., incl		Over 1½ to 4 in., incl		Over ¾ to 4 in., incl	
Analysis	Ladle	Check	Ladle	Check	Ladle	Check
Manganese, per cent	0.80 to 1.10	0.76 to 1.14	0.85 to 1.20	0.80 to 1.25	0.60 to 0.90	0.57 to 0.93
Silicon, per cent	...	...	0.15 to 0.30	0.13 to 0.33	...	...

Tensile Properties

7. (*a*) The material as represented by the test specimen, except as specified in Paragraph (*b*) of this Section, shall conform to the requirements as to tensile properties prescribed in Table IV.

(*b*) Shapes less than 1 sq in. in cross-section and bars, other than flats, less than ½ in. in thickness or diameter need not be subjected to tension tests by the manufacturer.

(*c*) For material under $\frac{5}{16}$ in. in thickness or diameter, a deduction from the percentage of elongation in 8 in., specified in Table IV, of 1.25 per cent shall be made for each decrease of $\frac{1}{32}$ in. of the specified thickness or diameter below $\frac{5}{16}$ in.

(*d*) For material over ⅝ in. in thickness or diameter, a deduction from the percentage of elongation in 8 in., specified in Table IV, of 0.50 per cent shall be made for each increase of ⅛ in. of the specified thickness or diameter above ⅝ in. This deduction shall not exceed 3 per cent.

(*e*) For material over 3½ in. in thickness or diameter, a deduction from the percentage of elongation in 2 in., specified in Table IV, of 0.50 per cent shall be made for each increase of ½ in. of the specified thickness or diameter above 3½ in.

TABLE IV.—TENSILE REQUIREMENTS.

	Plates, Shapes, and Bars
Tensile strength, psi	60 000 to 80 000
Yield point, min, psi	36 000
Elongation in 8 in., min, per cent	20[a]
Elongation in 2 in., min, per cent	23[b]

[a] See Section 7(*c*) and (*d*).
[b] See Section 7(*e*).

Bending Properties

8. The bend test specimens shall stand being bent cold through 180 deg without cracking on the outside of the bent portion, to an inside diameter which shall have a relation to the thickness of the specimen as prescribed in Table V.

TABLE V.—BEND TEST REQUIREMENTS.

Thickness of Material, in.	Ratio of Bend Diameter to Thickness of Specimen for Plates, Shapes, and Bars
¾ and under	½
Over ¾ to 1, incl	1
Over 1 to 1½, incl	1½
Over 1½ to 2, incl	2½
Over 2 to 4, incl	3

Number of Tests

9. Two tension and two bend tests shall be made from each heat, unless the finished material from a heat is less than 30 tons, when one tension test and one bend test will be sufficient. If, however, material from one heat differs ⅛ in. or more in thickness, one tension test and one bend test shall be made from both the thickest and the thinnest material rolled, regardless of the weight represented.

SPECIFICATION FOR MALLEABLE IRON CASTINGS

SA-47

(IDENTICAL WITH ASTM SPECIFICATION A 47-61 EXCEPT THAT GRADE NO. 32510 AND THE APPENDIX HAVE BEEN DELETED)

Scope

1. These specifications cover malleable iron to be used in castings for railroad, marine, motor vehicle, agricultural implement, and general machinery purposes at both normal and elevated temperatures.

Process

2. The iron shall be made by one of the following processes: air-furnace, open-hearth, electric-furnace, or by one of the multiplex processes.

Primary Graphite

3. Castings shall be free from primary graphite.

Tensile Properties

4. (*a*) The tension test specimen specified in Section 5 shall conform to the following requirements as to tensile properties:

	Grade No. 35018
Tensile strength, min., psi	53 000
Yield point, min., psi	35 000
Elongation in 2 in., min., per cent	18

(*b*) The yield point may be determined by the drop of the beam or halt in the gage of the testing machine, or by the dividers method. If determined by the dividers method the stress producing an elongation under load of 0.01 in. over the gage length of 2 in. shall be taken as the yield point value.

(*c*) After reaching a stress equivalent to approximately 50 per cent of the anticipated yield point value, the speed of the moving head of the testing machine shall not exceed ½ in. per min. up to the yield point, and above the yield point, shall not exceed 2 in. per min.

Test Specimens

5. (*a*) Tension test specimens shall be of the form and dimensions shown in Fig. 1 or Fig. 2. Specimens whose mean diameter at the smallest section is less than $\frac{11}{32}$ in. will not be accepted for test.

(*b*) The manufacturer shall cast three or more test specimens from each heat in batch melting and at least every four hours of multiplex melting without chills, using heavy risers of sufficient height to secure sound bars. All specimens shall be suitably identified with the heat number in batch melting and with the pour period in multiplex melting.

(*c*) All test specimens shall be annealed in regular production annealing ovens as nearly as possible with castings which were made during the same operating heat or period.

Number of Tests

6. (*a*) The manufacturer shall test at least one annealed tension test specimen from each heat of batch melting or from each pour period of multiplex melting and shall record the results, except those of flawed bars, in permanent records. Such records covering the operating periods during which the purchaser's castings were produced should be available for examination by the purchaser's representative.

(*b*) The purchaser's representative may select and test tension specimens representing the approximate operating period during which the purchaser's castings were produced. The test results of flawed bars shall be discarded and duplicate bars shall be tested.

(*c*) Instead of conducting tests as provided in Paragraph (*b*), the representative of the purchaser may elect to examine the manufacturer's test records for the approximate period during which the purchaser's castings were produced. He may further request certified copies of any representative tests which he may select.

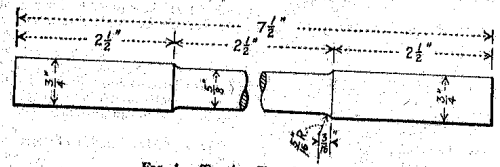
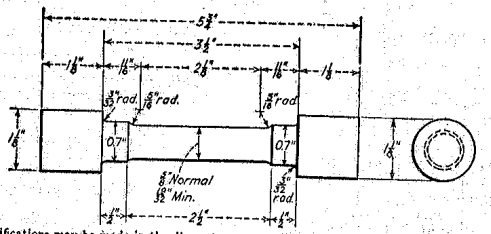


FIG. 1.—Tension Test Specimen.



NOTE.—Modifications may be made in the dimensions indicated above for those details of the specimen outside of the gage length as required by testing procedure and equipment.

FIG. 2.—Alternative Unmachined Tension Test Specimen.

Special Tests

7. (*a*) If specified by the purchaser, or if their inclusion is standard practice, as in the case of some railroad castings, test lugs shall be cast on all castings of sufficient size to permit their incorporation. They shall be of a size proportional to the thickness of the casting. On castings which are 24 in. or over in length, a test lug shall be cast near each end. The test lugs shall be attached to the castings at such locations that they will not interfere with the assembling of the castings, and may be broken off by the inspector.

(*b*) At the option of the purchaser or his representative, a casting of each design ordered may be tested to destruction, or otherwise broken up, to determine the presence of any manufacturing condition which may be detrimental to the serviceability of the casting. The fracture through any heavy sections of this casting may be examined for the presence of primary graphite referred to in Section 3.

Reannealing

8. Any castings rejected for improper annealing may be reannealed once. The reannealed castings shall be inspected and if the remaining test lugs, or castings broken as specimens, show the castings to be properly annealed, they shall be accepted; if not, they shall be finally rejected.

Permissible Variations in Dimensions

9. A variation of ⅛ in. per ft. in any dimension will be permitted.

Workmanship and Finish

10. The castings shall be free from injurious defects. They shall conform substantially to the patterns or drawings furnished by the purchaser, and to gages which may be specified in individual cases.

Marking

11. The identification mark of the manufacturer and the pattern numbers assigned by the purchaser shall be cast on all castings of sufficient size, in such positions that they will not interfere with the service of the castings.

Inspection

12. (*a*) The inspector representing the purchaser shall have free entry, at all times while work on the contract of the purchaser is being performed, to all parts of the manufacturer's works that concern the manufacture of the material ordered. The manufacturer shall afford the inspector, without charge, all reasonable facilities to satisfy him that the material is being furnished in accordance with these specifications. All tests and inspection shall be made at the place of manufacture prior to shipment, unless otherwise specified, and shall be so conducted as not to interfere unnecessarily with the operation of the works.

(*b*) The manufacturer shall be required to keep a record of each melt from which castings are produced, showing tensile strength and elongation of test specimens cast from such melts. These records shall be available and shown to the inspector whenever required.

Rejection

13. Material that shows injurious defects subsequent to its acceptance at the manufacturer's works may be rejected, and, if rejected, shall be replaced by the manufacturer without charge to the purchaser.

SPECIFICATION FOR WELDED AND SEAMLESS STEEL PIPE

SA-53

(IDENTICAL WITH ASTM SPECIFICATION A 53-61T)

Scope

1. (*a*) This specification covers seamless and welded black and hot-dipped galvanized steel pipe furnished in the following types and grades:

Type F.—Furnace-butt welded.

Type E.—Electric-resistance welded, Grades A and B.

Type S.—Seamless, Grades A and B.

NOTE 1.—See the Appendix for definitions of types of pipe.

(*b*) Pipe ordered under this specification is nominal (average) wall thickness, suitable for welding, and suitable for forming operations involving coiling, bending and flanging, subject to the following qualifications:

(*1*) Type F is not intended for flanging.

(*2*) When Types S and E are required for close coiling or cold bending, Grade A should be specified. This provision is not intended to prohibit the cold bending of Grade B pipe.

(*3*) When pipe is required for close coiling, this should be so specified on the order.

Materials and Manufacture

2. The steel for both seamless and welded pipe shall be made by one or more of the following processes: open-hearth, electric-furnace, basic-oxygen, or acid-bessemer, except that steel for Grade B bessemer pipe shall be killed steel made by the deoxidized-acid-bessemer process.

NOTE 2.—Deoxidized-bessemer steel for seamless pipe is an acid bessemer steel which has had a considerable portion of dissolved oxygen removed as a gas by treatment in a vessel and has been further treated to develop a silicon content of 0.10 to 0.30 per cent, and with sufficient aluminum, or its equivalent, to insure practically no evolution of gases during solidification. (Killed-bessemer steel may also be deoxidized by treatment in the ladle with sufficient aluminum, or its equivalent, to insure practically no evolution of gases during solidification.)

Chemical Composition

3. The steel shall conform to the requirements as to chemical composition specified in Table I.

Check Analysis

4. (*a*) An analysis of two pipes from each lot of 500 lengths, or fraction thereof, may be made by the purchaser. Samples for chemical analysis, except for spectrographic analysis, shall be taken in accordance with the Method of Sampling Steel, Cast Iron, Open Hearth Iron, and Wrought Iron (ASTM Designation: E 59). The chemical composition thus determined shall conform to the requirements specified in Table I.

TABLE I.—CHEMICAL REQUIREMENTS.

		Phosphorus, max, per cent
Type S (seamless pipe)	open-hearth or basic-oxygen	0.048
	bessemer	0.11
Type F (furnace-welded pipe)	open-hearth or basic-oxygen	0.08
	bessemer	0.13
Type E (electric-resistance-welded)	open-hearth or basic-oxygen	0.050

(*b*) If the analysis of either pipe does not conform to the requirements specified in Table I, analyses shall be made on additional pipes of double the original number from the same lot, each of which shall conform to the requirements specified.

Tensile Properties

5. (*a*) The material shall conform to the requirements as to tensile properties prescribed in Table II.

(*b*) The yield point shall be determined by the drop of the beam or by the halt in the gage of the testing machine, by the use of dividers, or by other approved methods. When a definite yield point is not exhibited, the yield strength corresponding to a permanent offset of 0.2 per cent of the gage length of the specimen or to a total extension of 0.5 per cent of the gage length under load shall be determined.

(*c*) The test specimen taken across the weld shall show a tensile strength not less than the minimum tensile strength specified for the grade of pipe ordered. This test will not be required for pipe under 8 in. in outside diameter

Bending Properties

6. For pipe 2 in. and under in nominal diameter, a sufficient length of pipe shall stand being bent cold through 90 deg around a cylindrical mandrel, the diameter of which is twelve times the nominal diameter of the pipe, without developing cracks at any portion and without opening the weld. When ordered for close coiling, the pipe shall stand being bent cold through 180 deg around a cylindrical mandrel, the diameter of which is eight times the nominal diameter of the pipe, without failure. Double-extra-strong pipe over 1¼ in. in diameter need not be subjected to the bend test.

TABLE II.—TENSILE REQUIREMENTS.

	Type F		Types E and S	
	Acid-Bessemer	Open-Hearth, Basic Oxygen, or Electric-Furnace	Grade A	Grade B
Tensile strength, min, psi	50 000	45 000	48 000	60 000
Yield point, min, psi	30 000	25 000	30 000	35 000
Elongation in 8 in., min, per cent	18[a]	20[a]	...	...
Elongation in 2 in., min, per cent:				
Basic minimum elongation for walls 5/16 in. and over in thickness, longitudinal strip tests, and for all small sizes tested in full section	...	...	35	30
When standard round 2-in. gage length test specimen is used	...	30	28	22
For longitudinal strip tests the width of the gage section shall be 1½ in. and a deduction for each 1/32-in. decrease in wall thickness below 5/16 in. from the basic minimum elongation of the following percentage	...	...	1.75[b]	1.50[b]

[a] Gage distances for measuring elongation on furnace-welded pipe of nominal sizes ¾ in. and smaller shall be as follows:

Nominal Size, in.	Gage Length, in.
⅛ and ¼	0
⅜ and ½	4
¾	2

[b] The following table gives the computed minimum values:

Wall Thickness, in.	Elongation in 2 in., min, per cent	
	Grade A	Grade B
5/16 (0.312)	35.00	30.00
9/32 (0.281)	33.25	28.50
¼ (0.250)	31.50	27.00
7/32 (0.219)	29.75	25.50
3/16 (0.188)	28.00	24.00
5/32 (0.156)	26.25	22.50
⅛ (0.125)	24.50	21.00
3/32 (0.094)	22.75	19.50
1/16 (0.062)	21.00	18.00

NOTE.—The above table gives the computed minimum elongation values for each 1/32-in. decrease in wall thickness. Where the wall thickness lies between two values shown above, the minimum elongation value shall be determined by the following formula:

Grade	Formula
A	$E = 56\,t + 17.50$
B	$E = 48\,t + 15.00$

where:
E = elongation in 2 in. in per cent, and
t = actual thickness of specimen, in inches.

Flattening Test

7. (*a*) The flattening test shall be made on standard weight and extra strong pipe over 2 in. in nominal diameter. It shall not be required for double extra strong pipe.

(*b*) *Seamless Pipe.*—For seamless pipe a section not less than 2½ in. in length shall be flattened cold between parallel plates in two steps. During the first step, which is a test for ductility, no cracks or breaks on the inside or outside or end surfaces shall occur until the distance between the plates (Table III) is less than the value of "*H*" calculated by the following formula:

$$H = \frac{(1 + e)t}{e + t/D}$$

where:

H = distance between flattening plates, in inches (Note 3),
e = deformation per unit length (constant for a given grade of steel, 0.09 for Grade A and 0.07 for Grade B),
t = nominal wall thickness of pipe, in inches, and
D = actual outside diameter of pipe, in inches.

During the second step, which is a test for soundness, the flattening shall be continued until the specimen breaks or the opposite walls of the pipe meet. Evidence of laminated or unsound material that is revealed during the entire flattening test shall be cause for rejection.

TABLE III.—FLATTENING REQUIREMENTS.

Kind of Pipe	Distance Between Plates, "H"
Butt-welded	60 per cent of outside diameter
Electric-resistance-welded, Grades A and B	one-third of outside diameter
Seamless, Grades A and B	to the distance "H"

NOTE 3.—The "H" values have been calculated for standard and extra-heavy weight sizes from 2½ to 24 in., inclusive, and are shown in Table IV.

(*c*) *Electric-Resistance-Welded Steel Produced in Single Lengths.*—The crop ends cut from each end of each length shall be flattened between parallel plates until opposite walls of the pipe meet. The tests from each end shall be made alternately with the welds at 0 deg and 90 deg (point of maximum bending). No opening in the weld shall take place until the distance between the plates is less than two thirds of the original outside diameter of the pipe, and no cracks or breaks in the metal, elsewhere than in the weld, shall occur until the distance between the plates is less than one third of the original outside diameter of the pipe. Also, evidence of laminations or burnt metal shall not develop during

the entire flattening operation. If any crop end fails to conform to these requirements, additional tests shall be made on specimens cut from the same end of the same length of pipe until the requirements are met, except that the finished pipe shall not be shorter than 80 per cent of its length after the initial cropping. Precautions shall be taken that crop ends can be identified with respect to the length of pipe from which they were cut.

(*d*) *Electric-Resistance-Welded Steel Produced in Multiple Lengths and Subsequently Cut into Single Lengths.*—A flattening test shall be made as described in Paragraph (*c*) on test specimens cut from each end of each multiple length with the weld at 90 deg (point of maximum bending). Tests also shall be made on two intermediate rings cut from each multiple length of pipe with the weld at 0 deg. If any of the specimens fail to conform to the requirements specified in Paragraph (*c*) the manufacturer may elect to make retests cut from each end of each individual length as provided in Paragraph (*c*). The retests for each end of each individual length for electric-resistance-welded steel pipe shall be made with the welds alternately at 0 deg and 90 deg.

(*e*) *Butt Welded Pipe.*—For butt welded pipe a specimen not less than 4 in. in length shall be flattened cold between parallel plates in three steps. The weld shall be located 45 deg from the line of direction of force. During the first step, which is a test for quality of the weld, no cracks or breaks on the inside, outside or end surfaces shall occur until the distance between the plates is less than three fourths of the original outside diameter for butt welded pipe. As a second step, the flattening shall be continued. During the second step, which is a test for ductility exclusive of the weld, no cracks or breaks on the inside, outside or end surfaces shall occur until the distance between the plates is less than 60 per cent of the original outside diameter for butt welded pipe. During the third step, which is a test for soundness, the flattening shall be continued until the specimen breaks or the opposite walls of the pipe meet. Evidence of laminated or unsound material or of incomplete weld that is revealed during the entire flattening test shall be cause for rejection.

(*f*) Surface imperfections in the test specimen before flattening, but revealed during the first step of the flattening test, shall be judged in accordance with the finish requirements in Section 16.

(*g*) Superficial ruptures as a result of surface imperfections shall not be cause for rejection.

Hydrostatic Test

8. (*a*) Each length of plain-end pipe shall be tested at the mill to the hydrostatic pressures prescribed in Table V, and each threaded-and-coupled length shall be hydrostatically tested to pressures prescribed in Table VI. The hydrostatic test may be applied, at the discretion of the manufacturer, on pipe with plain ends, with threads only, or with threads and couplings. Welded pipe 2 in. and larger shall be jarred near one end while under test pressure.

(*b*) The maximum hydrostatic test pressure shall not exceed 2500 psi for nominal sizes 3 in. and under, or 2800 psi for all nominal sizes over 3 in. The hydrostatic pressure shall be maintained for not less than 5 sec for all sizes of seamless and electric-welded pipe.

Methods of Test

9. (*a*) The test specimens and the tests required by this specification shall conform to those described in the latest issue of the Methods and Definitions for the Mechanical Testing of Steel Products (ASTM Designation: A 370).

(*b*) The longitudinal tension test specimen shall be taken from the end of the pipe or, by agreement between the manufacturer and the purchaser, may be taken from the skelp, at a point approximately 90 deg from the weld, and shall not be flattened between gage marks. The sides of each specimen shall be parallel between gage marks. If desired, the tension test may be made on the full section of pipe. When impracticable to pull a test specimen in full thickness, the standard 2 in. gage length tension test specimen shown in Fig. 6 of Methods A 370 may be used.

(*c*) Transverse weld test specimens from electric-welded pipe shall be taken with the weld at the center of the specimen. All transverse test specimens shall be approximately 1½ in. wide in the gage length and shall represent the full wall thickness of the pipe from which the specimen was cut.

(*d*) Test specimens for the bend and flattening tests shall consist of sections cut from a pipe. Specimens for flattening tests shall be smooth on the ends and free from burrs, except when made on crop ends taken from welded pipe.

(*e*) All specimens shall be tested at room temperature.

Number of Tests

10. (*a*) One of each of the tests specified in Sections 5, 6, and 7, except 7(*c*), shall be made on one length of pipe from each lot of 500 lengths, or fraction thereof, of each size. A length is defined as the length as ordered, except that in the case of orders for cut lengths shorter than single random, the term lot shall apply to the lengths as rolled, prior to cutting to the required short lengths.

(*b*) The flattening test specified in Section 7(*c*) shall be made on both crop ends from each length of pipe.

(*c*) In the case of welded pipe ordered for flanging, the crop ends cut from each length shall be subjected to the flattening test specified in Section 7.

(*d*) Each length of pipe shall be subjected to the hydrostatic test specified in Section 8.

Retests

11. (*a*) If the results of the mechanical tests of any lot do not conform to the requirements specified in Sections 5, 6 and 7, retests may be made on additional pipe of double the original number from the same lot, each of which shall conform to the requirements specified.

(*b*) If any section fails when flattening tests are made on the crop ends of each length of welded pipe, other pieces from the length may be cut until satisfactory tests are obtained, otherwise the length shall be rejected.

Dimensions and Weights

12. (*a*) The dimensions and weights of plain-end pipe included in this specification are listed in Table V. Dimensions and weights of threaded-and-coupled pipe are listed in Table VI.

(*b*) The dimensions and weights furnished under this specification are included in the American Standard for Steel and Wrought-Iron Pipe (ASA B36.10-1959).

Permissible Variations in Weight and Dimensions

13. (*a*) *Weight.*—The weight of the pipe as specified in Tables V and VI shall not vary by more than the following amounts:

Extra-strong and lighter wall thickness.	±5 per cent
Heavier than extra-strong wall thickness.	±10 per cent

(*b*) *Diameter.*—For pipe 1½ in. and under in nominal diameter, the outside diameter at any point shall not vary more than 1/64 in. over nor more than 3/32 in. under the standard specified. For pipe 2 in. and over in nominal diameter, the outside diameter shall not vary more than ±1 per cent from the standard specified.

(*c*) *Thickness.*—The minimum wall thickness at any point shall be not more than 12.5 per cent under the nominal wall thickness specified. The minimum wall thickness on inspection shall conform to the requirements in Table VII.

Lengths

14. Unless otherwise specified, pipe lengths shall be in accordance with the following regular practice:

(*a*) Pipe of weights lighter than extra-strong shall be in single-random lengths of 16 to 22 ft, but not more than 5 per cent of the total number of threaded lengths may be jointers, which are two pieces coupled together. When ordered with plain ends, 5 per cent may be in lengths of 12 to 16 ft.

(*b*) Pipe of extra-strong and heavier weights shall be in random lengths of 12 to 22 ft. Five per cent may be in lengths of 6 to 12 ft.

(*c*) When extra-strong or lighter pipe is ordered in double-random lengths, the minimum lengths shall be not less than 22 ft, with a minimum average for the order of 35 ft.

(*d*) When lengths longer than single random are required for wall thicknesses heavier than extra-strong, the length shall be subject to negotiation.

End Finish

15. (*a*) *Plain End.*—Pipe sizes and weights shown in Table V ordered with plain ends shall be furnished to the following regular practices, unless otherwise specified:

(*1*) Pipe of standard or extra-strong weights, or in wall thicknesses less than 0.500 in., other than double-extra-strong pipe, shall be plain end beveled.

(*2*) Pipe with wall thicknesses over 0.500 in. and all double-extra-strong pipe shall be plain end cut square.

(*3*) Plain end pipe ⅜ in. and smaller shall be square cut.

(*b*) *Threaded End.*—The sizes and weights shown in Table VI may be ordered with threads and couplings, and when so ordered, the ends shall be provided with threads in accordance with the gaging practice of the American Standard for Pipe Threads (ASA B2.1-1945). The variation from standard, when tested with the standard working gage, shall not exceed 1½ turns either way. For standard-weight pipe in sizes 6 in. and smaller, refer to Table VIII for basic threading data, and Fig. 1 for an illustration of the joint. For standard-weight pipe in sizes 8 in. and larger and for all sizes of extra-strong-weight and double-extra-strong-weight pipe, refer to Table IX for basic threading data and Fig. 2 for an illustration of the joint.

(*c*) *Couplings.*—Each length of threaded pipe shall be provided with one coupling, unless otherwise specified. The coupling threads shall be in accordance with the gaging practice of the American Standard for Pipe Threads (ASA B2.1-1945). The coupling shall be applied hand-tight, unless power-tight is specified on the order. Couplings may be wrought-iron or steel. Taper-tapped couplings shall be furnished on all weights of threaded pipe 2½ in. and larger. For sizes 2 in. and smaller, it is regular practice to furnish straight-tapped couplings for standard-weight pipe and taper-tapped couplings for extra-strong and double-extra-strong pipe, and standard-weight pipe 8 in. and larger. If taper-tapped couplings are required for sizes 2 in. and under on standard-weight pipe, line pipe in accordance with Specification 5L of the American Petroleum Institute should be ordered. The taper-tapped couplings provided on line pipe in these sizes may be used on mill-threaded standard-weight pipe of the same size.

Galvanized Pipe

16. (*a*) Galvanized pipe ordered under this specification shall be coated with zinc inside and outside by the hot-dip process. The zinc used for the coating shall be any grade of zinc conforming to the Specification for Slab Zinc (Spelter) (ASTM Designation: B 6).

(*b*) *Weight of Coating.*—The weight of zinc coating shall be not less than 2.0 oz per sq ft of total coated surface as determined in the manner prescribed in Section 16(*c*). The weight of coating expressed in ounces per square foot shall be calculated by dividing the total weight of zinc, inside plus outside, by the total area, inside plus outside, of the surface coated.

(*c*) *Weight of Coating Test.*—The weight of zinc coating shall be determined by a stripping test in accordance with the Methods of Test for Weight of Coating on Zinc-Coated (Galvanized) Iron or Steel Articles (ASTM Designation: A 90). The total zinc on each specimen shall be determined in a single stripping operation and the average of the results from the two specimens from each pipe shall be the weight of zinc coating.

(*d*) *Test Specimens.*—Test specimens for determination of weight of coating shall be cut approximately 4 in. in length from opposite ends of the lengths of pipe selected for testing.

(*e*) *Number of Tests.*—Two test specimens for the determination of weight of coating shall be taken, one from each end of one length of galvanized pipe selected at random from each lot of 500 lengths, or fraction thereof, of each size.

(*f*) *Retests.*—If the weight of coating of any lot does not conform to the requirements specified in Section 16(*b*), retests of two additional pipes from the same lot shall be made, each of which shall conform to the requirements specified.

(*g*) When pipe ordered under this specification is to be galvanized, the tension, flattening and bend tests shall be made on the base material before galvanizing. When specified, results of the mechanical tests on the base material shall be reported to the purchaser. If impracticable to make the mechanical

tests on the base material before galvanizing, such tests may be made on galvanized samples, and any flaking or cracking of the zinc coating shall not be considered cause for rejection. When galvanized pipe is bent or otherwise fabricated to a degree which causes the zinc coating to stretch or compress beyond the limit of elasticity, some flaking of the coating may occur.

Workmanship

17. The finished pipe shall be reasonably straight and free from injurious defects. All burrs at the ends of the pipe shall be removed.

Marking

18. (*a*) Each length of pipe shall be legibly marked by rolling, stamping or stenciling to show: the name or brand of the manufacturer; the kind of pipe, that is, furnace-butt-welded, electric-resistance-welded A, electric-resistance-welded B, seamless A, or seamless B; the use of electric-furnace, basic-oxygen, or acid-bessemer steel; XS for extra strong, XXS for double extra strong; ASTM A 53; and the length.

(*b*) For small diameter pipe which is bundled, this information may be marked on a tag securely attached to each bundle.

Inspection

19. The inspector representing the purchaser shall have free entry, at all times while work on the contract of the purchaser is being performed, to all parts of the manufacturer's works that concern the manufacture of the material ordered. The manufacturer shall afford the inspector, without charge, all reasonable facilities to satisfy him that the material is being furnished in accordance with this specification. All tests (except check analysis) and inspection shall be made at the place of manufacture prior to shipment, unless otherwise specified, and shall be so conducted as not to interfere unnecessarily with the operation of the works.

Rejection

20. Each length of pipe that develops injurious defects during shop working or application operations will be rejected and the manufacturer shall be notified.

APPENDIX

Definitions of Types of Pipe

1A. *Type F, Furnace-Butt-Welded Pipe, Bell-Welded.*—Pipe produced in individual lengths from cut-length skelp, having its longitudinal butt joint forge welded by the mechanical pressure developed in drawing the furnace-heated skelp through a cone-shaped die (commonly known as the "welding bell") which serves as a combined forming and welding die.

2A. *Type F, Furnace-Butt-Welded Pipe, Continuous-Welded.*—Pipe produced in continuous lengths from coiled skelp and subsequently cut into individual lengths, having its longitudinal butt joint forge welded by the mechanical pressure developed in rolling the hot-formed skelp through a set of round pass welding rolls.

3A. *Type E, Electric-Resistance-Welded Pipe.*—Pipe produced in individual lengths or in continuous lengths from coiled skelp and subsequently cut into individual lengths, having a longitudinal butt joint wherein coalescence is produced by the heat obtained from resistance of the pipe to the flow of electric current in a circuit of which the pipe is a part, and by the application of pressure.

4A. *Type S, Wrought Steel Seamless Pipe.*—Wrought steel seamless pipe is a tubular product made without a welded seam. It is manufactured by hot working steel and, if necessary, by subsequently cold finishing the hot-worked tubular product to produce the desired shape, dimensions, and properties.

Tables for Chemical and Dimensional Requirements

APPENDIX I

TABLE IV.—CALCULATED "H" VALUES FOR SEAMLESS PIPE.

Size (Nominal Inside Diameter), in.	Outside Diameter, in.	Wall Thickness, in.	Distance, in Inches, Between Plates "H" by Formula: $H = \frac{(1+e)T}{e+1/d}$	
			Grade A	Grade B
2½	2.875	0.203	1.378	1.545
		0.276	1.618	1.779
3	3.500	0.216	1.552	1.755
		0.300	1.861	2.062
3½	4.000	0.226	1.682	1.912
		0.318	2.045	2.276
4	4.500	0.237	1.811	2.067
		0.337	2.228	2.489
5	5.563	0.258	2.062	2.372
		0.375	2.597	2.920
6	6.625	0.280	2.308	2.669
		0.432	3.034	3.419
8	8.625	0.277	2.473	2.902
		0.322	2.757	3.210
		0.500	3.683	4.181
10	10.750	0.279[a]	2.623	3.111
		0.307	2.823	3.333
		0.365	3.210	3.757
		0.500	3.993	4.592
12	12.750	0.330	3.105	3.683
		0.375	3.423	4.037
		0.500	4.218	4.899
14	14.000	0.375	3.500	4.146
		0.500	4.336	5.061
16	16.000	0.375	3.603	4.294
		0.500	4.494	5.284
18	18.000	0.375	3.688	4.417
		0.500	4.628	5.472
20	20.000	0.375	3.758	4.521
		0.500	4.740	5.632
24	24.000	0.375	3.869	4.686
		0.500	4.918	5.890

[a] Special order only.

TABLE V.—DIMENSIONS, WEIGHTS, AND TEST PRESSURES FOR PLAIN END PIPE.

Nominal Size, in.	Outside Diameter, in.	Wall Thickness, in.	Nominal Weight per ft, Plain End, lb	Weight Class	Schedule No.	Test Pressure, psi		
						Butt-Welded	Grade A	Grade B
⅛	0.405	0.068	0.24	STD	40	700	700	700
		0.095	0.31	XS	80	850	850	850
¼	0.540	0.088	0.42	STD	40	700	700	700
		0.119	0.54	XS	80	850	850	850
⅜	0.675	0.091	0.57	STD	40	700	700	700
		0.126	0.74	XS	80	850	850	850
½	0.840	0.109	0.85	STD	40	700	700	700
		0.147	1.09	XS	80	850	850	850
		0.294	1.71	XXS	....	1000	1000	1000
¾	1.050	0.113	1.13	STD	40	700	700	700
		0.154	1.47	XS	80	850	850	850
		0.308	2.44	XXS	....	1000	1000	1000
1	1.315	0.133	1.68	STD	40	700	700	700
		0.179	2.17	XS	80	850	850	850
		0.358	3.66	XXS	....	1000	1000	1000
1¼	1.660	0.140	2.27	STD	40	1000	1000	1100
		0.191	3.00	XS	80	1300	1500	1600
		0.382	5.21	XXS	....	1400	1800	1900
1½	1.900	0.145	2.72	STD	40	1000	1000	1100
		0.200	3.63	XS	80	1300	1500	1600
		0.400	6.41	XXS	....	1400	1800	1900
2	2.375	0.154	3.65	STD	40	1000	2300	2500
		0.218	5.02	XS	80	1300	2500	2500
		0.344	7.46	....	160	....	2500	2500
		0.436	9.03	XXS	....	1400	2500	2500
2½	2.875	0.203	5.79	STD	40	1000	2500	2500
		0.276	7.66	XS	80	1300	2500	2500
		0.375	10.01	....	160	1400	2500	2500
		0.552	13.70	XXS	....	1400	2500	2500
3	3.500	0.188	6.63	....	....	....	....	....
		0.216	7.58	STD	40	1000	2200	2500
		0.300	10.25	XS	80	1300	2500	2500
		0.438	14.31	....	160	....	2500	2500
		0.600	18.58	XXS	....	....	2500	2500
3½	4.000	0.188	7.63	....	....	....	....	....
		0.226	9.11	STD	40	1200	2000	2400
		0.318	12.51	XS	80	1700	2800	2800
4	4.500	0.156	7.25	....	....	....	....	....
		0.188	8.64	....	....	....	....	....
		0.219	10.00	....	....	....	....	....
		0.237	10.79	STD	40	1200	1900	2200
		0.337	14.98	XS	80	1700	2700	2800
		0.438	18.98	....	120	....	2800	2800
		0.531	22.52	....	160	....	2800	2800
		0.674	27.54	XXS	....	....	2800	2800
5	5.563	0.258	14.62	STD	40	....	1700	1900
		0.375	20.78	XS	80	....	2400	2800
		0.500	27.04	....	120	....	2800	2800
		0.625	32.96	....	160	....	2800	2800
		0.750	38.55	XXS	....	....	2800	2800

TABLE V.—*Continued*

Nominal Size, in.	Outside Diameter, in.	Wall Thickness, in.	Nominal Weight per Foot, Plain End, lb	Weight Class	Schedule No.	Test Pressure, psi		
						Butt-Welded	Grade A	Grade B
6	6.625	0.280	18.97	STD	40	....	1500	1800
		0.432	28.57	XS	80	....	2300	2700
		0.562	36.42	....	120	....	2800	2800
		0.710	45.34	....	160	....	2800	2800
		0.864	53.16	XXS	....	....	2800	2800
8	8.625	0.250	22.36	....	20	....	1000	1200
		0.277	24.70	....	30	....	1200	1300
		0.322	28.55	STD	40	....	1300	1600
		0.406	35.66	....	60	....	1700	2000
		0.500	43.39	XS	80	....	2100	2400
		0.594	50.93	....	100	....	2500	2800
		0.719	60.69	....	120	....	2800	2800
		0.812	67.79	....	140	....	2800	2800
		0.875	72.42	XXS	....	....	2800	2800
		0.906	74.71	....	160	....	2800	2800
10	10.750	0.250	28.04	....	20	....	850	1000
		0.279	31.20	....	....	....	950	1100
		0.307	34.24	....	30	....	1000	1200
		0.365	40.48	STD	40	....	1200	1400
		0.500	54.74	XS	60	....	1700	2000
		0.594	64.40	....	80	....	2000	2300
		0.719	77.00	....	100	....	2400	2800
		0.844	89.27	....	120	....	2800	2800
		1.000	104.13	XXS	140	....	2800	2800
		1.125	115.65	....	160	....	2800	2800
12	12.750	0.250	33.38	....	20	....	700	800
		0.330	43.77	....	30	....	950	1100
		0.375	49.56	STD	....	....	1100	1200
		0.406	53.56	....	40	....	1100	1300
		0.500	65.42	XS	....	....	1400	1600
		0.562	73.22	....	60	....	1600	1900
		0.688	88.57	....	80	....	1900	2300
		0.844	107.29	....	100	....	2400	2800
		1.000	125.49	XXS	120	....	2800	2800
		1.125	139.68	....	140	....	2800	2800
		1.312	160.33	....	160	....	2800	2800
14	14.000	0.250	36.71	....	10	....	650	750
		0.312	45.68	....	20	....	800	950
		0.375	54.57	STD	30	....	950	1100
		0.438	63.37	....	40	....	1100	1300
		0.500	72.09	XS	....	....	1300	1500
		0.594	85.01	....	60	....	1500	1800
		0.750	106.13	....	80	....	1900	2300
		0.938	130.79	....	100	....	2400	2800
		1.094	150.76	....	120	....	2800	2800
		1.250	170.22	....	140	....	2800	2800
		1.406	189.15	....	160	....	2800	2800
16	16.000	0.250	42.05	....	10	....	550	650
		0.312	52.36	....	20	....	700	800
		0.375	62.58	STD	30	....	850	1000
		0.500	82.77	XS	40	....	1100	1300
		0.656	107.54	....	60	....	1500	1700
		0.844	136.58	....	80	....	1900	2200
		1.031	164.86	....	100	....	2300	2700
		1.219	192.40	....	120	....	2700	2800
		1.438	223.57	....	140	....	2800	2800
		1.594	245.22	....	160	....	2800	2800

TABLE V.—*Concluded.*

Nominal Size, in.	Outside Diameter, in.	Wall Thickness, in.	Nominal Weight per ft, Plain End, lb	Weight Class	Schedule No.	Test Pressure psi		
						Butt-Welded	Grade A	Grade B
18	18.000	0.250	47.39	....	10	....	500	600
		0.312	59.03	....	20	....	600	750
		0.375	70.59	STD	....	....	750	900
		0.438	82.06	....	30	....	900	1000
		0.500	93.45	XS	....	....	1000	1200
		0.562	104.76	....	40	....	1100	1300
		0.750	138.17	....	60	....	1500	1800
		0.938	170.84	....	80	....	1900	2200
		1.156	208.00	....	100	....	2300	2700
		1.375	244.14	....	120	....	2800	2800
		1.562	274.30	....	140	....	2800	2800
		1.781	308.55	....	160	....	2800	2800
20	20.000	0.250	52.73	....	10	....	450	500
		0.375	78.60	STD	20	....	700	800
		0.500	104.13	XS	30	....	900	1000
		0.594	123.06	....	40	....	1100	1200
		0.812	166.50	....	60	....	1500	1700
		1.031	208.92	....	80	....	1900	2200
		1.281	256.15	....	100	....	2300	2700
		1.500	296.37	....	120	....	2700	2800
		1.750	341.10	....	140	....	2800	2800
		1.969	379.14	....	160	....	2800	2800
24	24.000	0.250	63.41	....	10	....	400	450
		0.375	94.62	STD	20	....	550	650
		0.500	125.49	XS	....	....	750	900
		0.562	140.80	....	30	....	850	1000
		0.688	171.17	....	40	....	1000	1200
		0.938	230.92	....	....	....	....	....
		0.969	238.29	....	60	....	1500	1700
		1.219	296.53	....	90	....	1800	2100
		1.531	367.45	....	100	....	2300	2700
		1.812	429.50	....	120	....	2700	2800
		2.062	483.24	....	140	....	2800	2800
		2.344	542.09	....	160	....	2800	2800

TABLE VI.—DIMENSIONS, WEIGHTS, AND TEST PRESSURES FOR THREADED AND COUPLED PIPE.

Nominal Size, in.	Outside Diameter, in.	Wall Thickness, in.	Nominal Weight per ft, Threads and Couplings, lb	Weight Class	Schedule No.	Test Pressure, psi		
						Butt-Welded	Grade A	Grade B
⅛	0.405	0.068	0.24	STD	40	700	700	700
		0.095	0.32	XS	80	850	850	850
¼	0.540	0.088	0.42	STD	40	700	700	700
		0.119	0.54	XS	80	850	850	850
⅜	0.675	0.091	0.57	STD	40	700	700	700
		0.126	0.74	XS	80	850	850	850
½	0.840	0.109	0.85	STD	40	700	700	700
		0.147	1.09	XS	80	850	850	850
		0.294	1.72	XXS	....	1000	1000	1000

TABLE VI.—*Concluded*

Nominal Size, in.	Outside Diameter, in.	Wall Thickness, in.	Nominal Weight per ft, Threads and Couplings, lb	Weight Class	Schedule No.	Test Pressure, psi		
						Butt-Welded	Grade A	Grade B
¾	1.050	0.113	1.13	STD	40	700	700	700
		0.154	1.48	XS	80	850	850	850
		0.308	2.44	XXS	....	1000	1000	1000
1	1.315	0.133	1.68	STD	40	700	700	700
		0.179	2.18	XS	80	850	850	850
		0.358	3.66	XXS	....	1000	1000	1000
1¼	1.660	0.140	2.28	STD	40	800	1000	1100
		0.191	3.02	XS	80	1300	1500	1600
		0.382	5.22	XXS	....	1400	1800	1900
1½	1.900	0.145	2.73	STD	40	800	1000	1100
		0.200	3.66	XS	80	1300	1500	1600
		0.400	6.41	XXS	....	1400	1800	1900
2	2.375	0.154	3.68	STD	40	800	1000	1100
		0.218	5.07	XS	80	1300	1500	1600
		0.436	9.03	XXS	....	1400	1800	1900
2½	2.875	0.203	5.82	STD	40	800	1000	1100
		0.276	7.73	XS	80	1300	1500	1600
		0.552	13.70	XXS	....	1400	1800	1900
3	3.500	0.216	7.62	STD	40	800	1000	1100
		0.300	10.33	XS	80	1300	1500	1600
		0.600	18.57	XXS	....	....	1800	1900
3½	4.000	0.226	9.20	STD	40	1200	1200	1300
		0.318	12.63	XS	80	1700	1700	1800
4	4.500	0.237	10.89	STD	40	1200	1200	1300
		0.337	15.17	XS	80	1700	1700	1800
		0.674	27.58	XXS	....	....	2000	2100
5	5.563	0.258	14.81	STD	40	....	1200	1300
		0.375	21.09	XS	80	....	1700	1800
		0.750	38.61	XXS	....	....	2000	2100
6	6.625	0.280	19.18	STD	40	....	1200	1300
		0.432	28.89	XS	80	....	1700	1800
		0.864	53.14	XXS	....	....	2000	2100
8	8.625	0.277	25.55	....	30	....	1200	1300
		0.322	29.35	STD	40	....	1300	1600
		0.500	43.90	XS	80	....	2100	2400
		0.875	72.44	XXS	....	....	2800	2800
10	10.750	0.279	32.75	....	....	....	950	1100
		0.307	35.75	....	30	....	1000	1200
		0.365	41.85	STD	40	....	1200	1400
		0.500	55.82	XS	60	....	1700	2000
12	12.750	0.330	45.45	....	30	....	950	1100
		0.375	51.15	STD	....	....	1100	1200
		0.500	66.71	XS	....	....	1400	1600

TABLE VII.—TABLE OF MINIMUM WALL THICKNESSES ON INSPECTION FOR NOMINAL (AVERAGE) PIPE WALL THICKNESSES.

NOTE 1.—The following formula, upon which this table is based, may be applied to calculate minimum wall thickness from nominal (average) wall thickness:

$$t_n \times 0.875 = t_m$$

where:

t_n = nominal (average) wall thickness in inches, and

t_m = minimum wall thickness in inches.

The wall thickness is expressed to three decimal places the fourth decimal place being carried forward or dropped in accordance with the Recommended Practices for Designating Significant Places in Specified Limiting Values (ASTM Designation: E 29).

NOTE 2.—This table is a master table covering wall thicknesses available in the purchase of different classifications of pipe, but it is not meant to imply that all of the walls listed therein are obtainable under this specification.

Nominal (Average) Thickness (t_n), in.	Minimum Thickness on Inspection (t_m), in.	Nominal (Average) Thickness (t_n), in.	Minimum Thickness on Inspection (t_m), in.	Nominal (Average) Thickness (t_n), in.	Minimum Thickness on Inspection (t_m), in.
0.068	0.060	0.294	0.257	0.750	0.656
0.088	0.077	0.300	0.262	0.812	0.710
0.091	0.080	0.307	0.269	0.844	0.739
0.095	0.083	0.308	0.270	0.864	0.756
0.109	0.095	0.312	0.273	0.875	0.766
0.113	0.099	0.318	0.278	0.906	0.793
0.119	0.104	0.322	0.282	0.938	0.821
0.125	0.109	0.330	0.289	0.968	0.847
0.126	0.110	0.337	0.295	1.000	0.875
0.133	0.116	0.343	0.300	1.031	0.902
0.140	0.122	0.344	0.301	1.062	0.929
0.145	0.127	0.358	0.313	1.094	0.957
0.147	0.129	0.365	0.319	1.125	0.984
0.154	0.135	0.375	0.328	1.156	1.012
0.156	0.136	0.382	0.334	1.219	1.067
0.179	0.157	0.400	0.350	1.250	1.094
0.187	0.164	0.406	0.355	1.281	1.121
0.188	0.164	0.432	0.378	1.312	1.148
0.191	0.167	0.436	0.382	1.343	1.175
0.200	0.175	0.437	0.382	1.375	1.203
0.203	0.178	0.438	0.383	1.406	1.230
0.216	0.189	0.500	0.438	1.438	1.258
0.218	0.191	0.531	0.465	1.500	1.312
0.219	0.192	0.552	0.483	1.531	1.340
0.226	0.198	0.562	0.492	1.562	1.367
0.237	0.207	0.594	0.520	1.594	1.395
0.250	0.219	0.600	0.525	1.750	1.531
0.258	0.226	0.625	0.547	1.781	1.558
0.276	0.242	0.656	0.574	1.812	1.586
0.277	0.242	0.674	0.590	1.968	1.722
0.279	0.244	0.688	0.602	2.062	1.804
0.280	0.245	0.719	0.629	2.344	2.051
0.281	0.246				

APPENDIX III

TABLE VIII.—BASIC THREADING DATA FOR STANDARD-WEIGHT PIPE SIZES 6 IN. AND UNDER.

NOTE 1.—All dimensions in this table are nominal and subject to mill tolerances.

NOTE 2.—The taper of threads is $\frac{3}{4}$ in. per ft on the diameter.

Pipe		Threads					Coupling		
Nominal Size, in.	Outside Diameter, in. D	Number per Inch	End of Pipe to Hand Tight Plane, in. L_1	Effective Length, in. L_2	Total Length, in. L_4	Pitch Diameter at Hand Tight Plane, in. E_1	Outside Diameter, in. W	Length, in. N_L	Hand Tight Stand-Off (Number of Threads) A
$\frac{1}{8}$	0.405	27	0.180	0.2638	0.3924	0.37476	0.563	$1\frac{3}{16}$	4
$\frac{1}{4}$	0.540	18	0.200	0.4018	0.5946	0.48989	0.719	$1\frac{5}{16}$	$5\frac{1}{2}$
$\frac{3}{8}$	0.675	18	0.240	0.4078	0.6006	0.62701	0.875	$1\frac{5}{16}$	5
$\frac{1}{2}$	0.840	14	0.320	0.5337	0.7815	0.77843	1.063	$1\frac{7}{16}$	5
$\frac{3}{4}$	1.050	14	0.339	0.5457	0.7935	0.98887	1.313	$1\frac{5}{8}$	5
1	1.315	$11\frac{1}{2}$	0.400	0.6828	0.9845	1.23863	1.576	2	5
$1\frac{1}{4}$	1.660	$11\frac{1}{2}$	0.420	0.7068	1.0085	1.58338	1.900	$2\frac{1}{16}$	5
$1\frac{1}{2}$	1.900	$11\frac{1}{2}$	0.420	0.7235	1.0252	1.82234	2.200	$2\frac{1}{16}$	$5\frac{1}{2}$
2	2.375	$11\frac{1}{2}$	0.436	0.7565	1.0582	2.29627	2.750	$2\frac{1}{8}$	$5\frac{1}{2}$
$2\frac{1}{2}$	2.875	8	0.682	1.1375	1.5712	2.76216	3.250	$3\frac{1}{8}$	$5\frac{1}{2}$
3	3.500	8	0.766	1.2000	1.6337	3.38850	4.000	$3\frac{1}{4}$	$5\frac{1}{2}$
$3\frac{1}{2}$	4.000	8	0.821	1.2500	1.6837	3.88881	4.625	$3\frac{3}{8}$	$5\frac{1}{2}$
4	4.500	8	0.844	1.3000	1.7337	4.38713	5.000	$3\frac{1}{4}$	5
5	5.563	8	0.937	1.4063	1.8400	5.44929	6.296	$3\frac{3}{4}$	5
6	6.625	8	0.958	1.5125	1.9462	6.50597	7.390	4	6

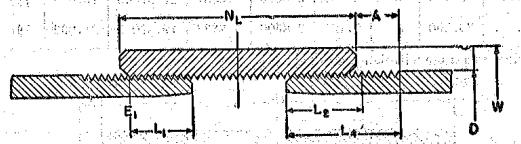


FIG. 1.—Dimensions of Hand Tight Assembly for Use with Table VIII.

TABLE IX.—BASIC THREADING DATA FOR STANDARD-WEIGHT PIPE IN SIZES 8 IN. AND LARGER, AND ALL SIZES OF EXTRA-STRONG AND DOUBLE-EXTRA-STRONG WEIGHT.

NOTE.—The taper of threads is ¾ in. per ft on the diameter.

Pipe		Threads					Coupling		
Nominal Size, in.	Outside Diameter, in.	Number per Inch	End of Pipe to Hand Tight Plane, in.	Effective Length, in.	Total Length, in.	Pitch Diameter at Hand Tight Plane, in.	Outside Diameter, in.	Length, in.	Hand Tight Stand-Off (Number of Threads)
	D		L_1	L_2	L_4	E_1	W	N_L	A
⅛	0.405	27	0.180	0.2638	0.3924	0.37476	0.563	1 1/16	3
¼	0.540	18	0.200	0.4018	0.5946	0.48989	0.719	1⅛	3
⅜	0.675	18	0.240	0.4078	0.6006	0.62701	0.875	1⅛	3
½	0.840	14	0.320	0.5337	0.7815	0.77843	1.063	2⅛	3
¾	1.050	14	0.339	0.5457	0.7935	0.98887	1.313	2⅛	3
1	1.315	11½	0.400	0.6828	0.9845	1.23863	1.576	2⅝	3
1¼	1.660	11½	0.420	0.7068	1.0085	1.58338	2.054	2¾	3
1½	1.900	11½	0.420	0.7235	1.0252	1.82234	2.200	2¾	3
2	2.375	11½	0.436	0.7565	1.0582	2.29627	2.875	2⅞	3
2½	2.875	8	0.682	1.1375	1.5712	2.76216	3.375	4⅛	2
3	3.500	8	0.766	1.2000	1.6337	3.38850	4.000	4¼	2
3½	4.000	8	0.821	1.2500	1.6837	3.88881	4.625	4⅜	2
4	4.500	8	0.844	1.3000	1.7337	4.38713	5.200	4½	2
5	5.563	8	0.937	1.4063	1.8400	5.44929	6.296	4⅝	2
6	6.625	8	0.958	1.5125	1.9462	6.50597	7.390	4⅞	2
8	8.625	8	1.063	1.7125	2.1462	8.50003	9.625	5¼	2
10	10.750	8	1.210	1.9250	2.3587	10.62094	11.750	5¾	2
12	12.750	8	1.360	2.1250	2.5587	12.61781	14.000	6⅛	2
14*	14.000	8	1.562	2.2500	2.6837	13.87263	15.000	6⅜	2
16*	16.000	8	1.812	2.4500	2.8837	15.87575	17.000	6¾	2
18*	18.000	8	2.000	2.6500	3.0837	17.87500	19.000	7⅛	2
20*	20.000	8	2.125	2.8500	3.2837	19.87031	21.000	7⅝	2

* Nominal size is outside diameter.

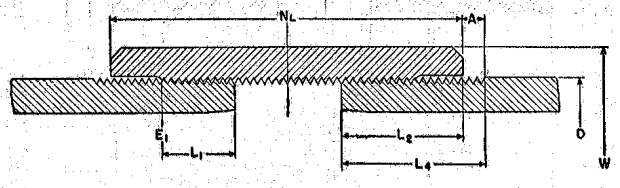


FIG. 2.—Dimensions of Hand Tight Assembly for Use with Table IX.

SPECIFICATION FOR WELDED WROUGHT IRON PIPE

SA-72

(IDENTICAL WITH ASTM SPECIFICATION A 72-61T)

Scope

1. (*a*) These specifications cover "standard weight," "extra strong," and "double extra strong" welded wrought-iron pipe, both black and galvanized. Pipe ordered under these specifications is intended for coiling, bending, flanging, and other special purposes. Butt-welded pipe is not intended for flanging and is not recommended for close bending or coiling in sizes 1¼ in. and over. The purpose for which the pipe is intended should be stated in the order.

(*b*) *Galvanized Pipe.*—When pipe ordered under these specifications is to be galvanized, the tension, flattening, and bend tests shall be made on the base material before galvanizing; or the mechanical tests may be made on galvanized samples, in which case any flaking or cracking of the zinc coating shall not be considered a cause for rejection. The zinc coating shall be tested in accordance with Section 12. When specified, results of the mechanical tests on the base material shall be reported to the purchaser.

Material and Process

2. (*a*) The pipe shall be made from all pig-puddled or processed wrought iron[3] and shall be free from any admixture of iron scrap (Note) or steel.

NOTE.—The term iron scrap applies only to foreign or bought scrap and does not include local mill products which are free from foreign or bought scrap. Any local mill products used shall be the equal of or a higher grade than the material specified.

(*b*) Wrought-iron pipe is produced by furnace welding either by the butt-weld or the lap-weld process. Sizes ¼ to 1 in. inclusive are butt-welded; sizes 1¼ to 4 in. inclusive are either butt-welded or lap-welded; sizes 4½ to 12 in. nominal and larger up to 14 in. in outside diameter inclusive are lap-welded. Sizes 16 in. in outside diameter and larger are produced in accordance with the Specification for Electric-Fusion (Arc)-Welded Wrought Iron Plate Pipe (ASTM Designation A 419).

[3] Wrought iron is defined as follows in the Definitions of Terms Relating to Wrought Iron (ASTM Designation: A 81):

Wrought Iron.—A ferrous material, aggregated from a solidifying mass of pasty particles of highly refined metallic iron with which, without subsequent fusion, is incorporated a minutely and uniformly distributed quantity of slag.

TABLE 1.—HYDROSTATIC TEST PRESSURES FOR WELDED WROUGHT-IRON PIPE.

(Pressures Expressed in Pounds per Square Inch.)[a]

Size (Nominal Inside Diameter), in.	Standard Weight Pipe		Extra Strong Pipe		Double Extra Strong Pipe	
	Butt Welded	Lap Welded	Butt Welded	Lap Welded	Butt Welded	Lap Welded
¼ to 1, incl.	700	...	850	...	1000	...
1¼ to 3, incl.	1000	1000	1300	1500	1400	1800
3½ to 4, incl.	1200	1200	1700	1700	...	2000
4½ to 8, incl.	...	1200	...	1700	...	2800
10 to 12, incl.	...	1000	...	1600	...	...

[a] For pipe over 12 in. in size, up to 14 in. in outside diameter inclusive, the test pressures should be calculated by the formula $P = \frac{2St}{D}$, where: P = pressure in pounds per square inch, S = fiber stress = 60 per cent of the specified yield point, t = thickness of wall in inches, and D = outside diameter in inches.

Chemical Composition

3. The iron shall conform to the following requirement as to chemical composition:

Manganese, max, per cent	0.06

Check Analysis

4. An analysis may be made by the purchaser from a broken tension-test specimen representing each lot. Drillings for analysis shall be so taken as to represent the entire cross-section of the specimen. The chemical composition thus determined shall conform to the requirement specified in Section 3.

Tensile Properties

5. (*a*) The material shall conform to the following requirements as to tensile properties:

Tensile strength, min, psi	42 000
Yield point, min, psi	25 000
Elongation in 8 in., min, per cent:	
full section	12
strip test	9

(*b*) The yield point shall be determined by the drop of the beam, by the halt in the gage of the testing machine, by the use of dividers, or by other approved methods. The speed of the crosshead of the machine shall not exceed ¾ in. per min.

Hydrostatic Tests

6. Each length of pipe shall be tested at the mill to the hydrostatic pressures prescribed in Table I. Pipe 2 in. and larger shall be jarred near one end while under test pressure.

Fracture Tests

7. A section of pipe 6 in. in length shall be flattened until broken by repeated light blows of a hammer or by pressure; the fracture developed shall have a fibrous appearance.

Bending Properties

8. For pipe 2 in. and under in diameter, a sufficient length of coiling or bending pipe shall stand being bent cold through 90 deg, around a cylindrical mandrel the diameter of which is 12 times the nominal diameter of the pipe, without developing cracks at any portion and without opening the weld. Double extra-strong pipe over 1½ in. in nominal size need not be subjected to the bend test.

Micrographic Examinations

9. In case of doubt as to the presence of steel, the purchaser may, at his own expense, make micrographic examination and chemical analysis to assist in determining whether the material conforms to the requirements specified in Sections 2 and 3.

Galvanized Pipe

10. (*a*) Galvanized pipe shall be coated with zinc inside and outside by the hot-dip process.

(*b*) The zinc used for the coating shall be any grade of zinc conforming to the Specifications for Slab Zinc (Spelter) (ASTM Designation: B 6).

Weight of Coating

11. The weight of zinc coating shall be not less than 2.0 oz per sq ft of total coated surface, as determined in the manner prescribed in Section 12. The weight of coating expressed in ounces per square foot shall be calculated by dividing the total weight of zinc, inside plus outside, by the total area, inside plus outside, of the surface coated.

Weight of Coating Test

12. The weight of zinc coating shall be determined by a stripping test made in accordance with the Methods of Test for Weight of Coating on Zinc-Coated (Galvanized) Iron or Steel Articles (ASTM Designation: A 90). The total zinc on each specimen shall be determined in a single stripping operation, and the average of the results from the two specimens from each pipe shall be the weight of zinc coating.

Test Specimens

13. (*a*) For pipe up to and including 2 in. in nominal size, tension test specimens shall be of the full section of the pipe. For pipe larger than 2 in. in nominal size, tension test specimens may be strips not less than ¾ in. in width, cut longitudinally from the pipe. The sides of such specimens shall be parallel and not flattened between gage marks.

(*b*) Test specimens for determination of weight of coating shall be cut approximately 4 in. in length from opposite ends of the lengths of pipe selected for testing.

(*c*) All specimens shall be tested at room temperature.

Number of Tests

14. (*a*) One of each of the tests specified in Sections 5, 7, and 8 shall be made on one length of pipe from each lot of 500 lengths or fraction thereof, of each size.

(*b*) Two test specimens for the determination of weight of coating shall be taken, one from each end of one length of galvanized pipe, selected at random from each lot of 500 lengths or fraction thereof of each size.

(*c*) Each length of pipe shall be subjected to the hydrostatic test specified in Section 6.

Retests

15. (*a*) If the results of the mechanical tests of any lot do not conform to the requirements specified in Sections 5, 7, and 8, retests of two additional pipes shall be made, each of which shall conform to the requirements specified.

(*b*) If the weight of coating of any lot does not conform to the requirements specified in Section 11, retests of two additional pipes from the same lot shall be made, each of which shall conform to the requirements specified.

Standard Weights

16. (*a*) The standard weights for pipe of various size (nominal inside diameter) are prescribed in Table II.

(*b*) Nipples shall be cut from pipe of the same weight and quality described in these specifications.

Permissible Variations in Weight and Diameter

17. (*a*) *Weight.*—The weight of the pipe shall not vary from that prescribed in Table II by more than ±5 per cent for standard weight and extra strong pipe nor more than ±10 per cent for double extra strong pipe.

(*b*) *Diameter.*—For pipe 1½ in. and under in nominal diameter, the outside diameter at any point shall not vary more than $\frac{1}{64}$ in. over nor more than $\frac{1}{32}$ in. under the standard specified. For pipe 2 in. and over in nominal diameter, the outside diameter shall not vary more than ±1 per cent from the standard specified.

(*c*) *Thickness.*—The minimum wall thickness at any point shall be not more than 12.5 per cent under the nominal wall thickness specified.

Lengths

18. Unless otherwise specified, pipe lengths shall be in accordance with the following regular practice:

(*a*) Standard weight pipe shall be in random lengths of 16 to 22 ft, but not more than 5 per cent of the total number of lengths may be "jointers," which are two pieces coupled together. When ordered with plain ends, 5 per cent may be in lengths of 12 to 16 ft.

(*b*) Extra strong and double extra strong pipe shall be in random lengths of 12 to 22 ft. Five per cent may be in lengths of 6 to 12 ft.

Workmanship

19. Unless otherwise specified, pipe shall conform to the following regular practice:

(*a*) *Ends.*—Each end of standard weight pipe shall be threaded. Extra strong and double extra strong pipe shall be furnished with plain ends.

(*b*) *Ends Beveled for Welding.*—When ends of pipe are ordered to be beveled for welding they shall be beveled to an angle of 30 deg +5, −0, measured at right angle to the axis of pipe except if otherwise specified.

TABLE II.—STANDARD WEIGHTS AND DIMENSIONS OF WELDED WROUGHT-IRON PIPE.[a]

Size (Nominal inside Diamter), in.	Outside Diameter, in.	Standard Weight Pipe			Extra-Strong Pipe		Double Extra-Strong Pipe	
		Number of Threads per Inch	Thickness, in.	Weight of Pipe per Linear Foot, Threaded and with Couplings, lb	Thickness, in.	Weight of Pipe per Linear Foot, Plain Ends, lb	Thickness, in.	Weight of Pipe per Linear Foot, Plain Ends, lb
⅛	0.540	18	0.090	0.42	0.122	0.54	.....	.....
¼	0.675	18	0.093	0.57	0.129	0.74	.....	.....
⅜	0.840	14	0.111	0.85	0.151	1.09	0.307	1.71
½	1.050	14	0.115	1.13	0.157	1.47	0.318	2.44
1	1.315	11½	0.136	1.68	0.183	2.17	0.369	3.66
1¼	1.660	11½	0.143	2.28	0.195	3.00	0.393	5.21
1½	1.900	11½	0.148	2.73	0.204	3.63	0.411	6.41
2	2.375	11½	0.158	3.68	0.223	5.02	0.447	9.03
2½	2.875	8	0.208	5.82	0.282	7.66	0.567	13.70
3	3.500	8	0.221	7.62	0.306	10.25	0.615	18.58
3½	4.000	8	0.231	9.20	0.325	12.51	0.651	22.85
4	4.500	8	0.242	10.89	0.344	14.98	0.690	27.54
5	5.563	8	0.263	14.81	0.383	20.78	0.768	38.55
6	6.625	8	0.286	19.18	0.441	28.57	0.884	53.16
*8	8.625	8	0.283	25.00	.....	.....	0.895	72.42
8	8.625	8	0.329	28.80	0.510	43.39	.....	.....
*10	10.750	8	0.284	32.00	.....	.....	.....	.....
*10	10.750	8	0.313	35.00	.....	.....	.....	.....
10	10.750	8	0.372	41.13	0.510	54.74	.....	.....
*12	12.750	8	0.336	45.00	.....	.....	.....	.....
12	12.750	8	0.383	50.70	0.510	65.42	.....	.....

[a] Weights prescribed in this table are for pipe 12 in. and under in nominal size; sizes larger than those shown in the table are measured by the outside diameter and will be furnished with plain ends unless otherwise specified; for such sizes it will be necessary to accept manufacturers' weights or calculate the weights on the basis of 1 cu in. of wrought iron weighing 0.27777 lb.

* Unless specifically stated on the order, the lighter weights will not be furnished.

(*c*) *Threads.*—The threads on the pipe shall be produced in conformity with the gaging practice of the American Standard for Pipe Threads,[7] and cut so as to assure a leak-proof joint when pipe with a power tight coupling is tested at the mill to the specified internal hydrostatic pressure.

(*d*) *Couplings.*—Each length of threaded pipe is to be provided with one coupling, which shall be tapped in accordance with the gaging practice of the American Standard for Pipe Threads.[7] Straight tapped couplings are furnished on pipe up to 2 in. in size; and taper tapped couplings on pipe 2½ in. and larger in size. Couplings shall be of wrought iron and they shall be marked with the manufacturer's name or brand.

[7] A complete description of the American Standard Pipe Threads applicable to pipe, valves, and fittings is contained in the American Standard for Pipe Threads (ASA No.: B2.1—1945); also "Screw-Thread Standards for Federal Services, 1942," National Bureau of Standards *Handbook H 28* January, 1942, the pertinent data in both sources being identical.

Finish

20. The finished pipe shall be reasonably straight and free from injurious defects. All burrs at the ends of the pipe shall be removed. Ordinary liquor marks incident to the manufacture of welded material will not be considered cause for rejection.

Marking

21. (*a*) Each length of pipe shall be legibly marked either by hot rolling, or by die stamping, or by stenciling, to show the name or the trade-mark of the manufacturer.

(*b*) The words WROUGHT IRON, the size and class of pipe, its length, the hydrostatic test pressure, and ASTM A-72 is to be stenciled on those sizes of pipe large enough to take this information.

(*c*) Smaller sizes of pipe that are bundled, in addition to the marking specified in Paragraph (*a*), shall show the manufacturer's name, the material, and the total footage of pipe on a tag securely attached to each bundle.

Inspection

22. The inspector representing the purchaser shall have free entry, at all times while work on the contract of the purchaser is being performed, to all parts of the manufacturer's works which concern the manufacture of the material ordered. The manufacturer shall afford the inspector, without charge, all reasonable facilities to satisfy him that the material is being furnished in accordance with these specifications. All tests (except check analysis) and inspection shall be made at the place of manufacture prior to shipment, unless otherwise specified, and shall be so conducted as not to interfere unnecessarily with the operation of the works.

Certification

23. In lieu of inspection by the purchaser's representative, when agreed upon in writing by the purchaser and the supplier, a certification shall be made the basis of acceptance of the material. This shall consist of a copy of the manufacturer's test report, or a statement by the supplier, accompanied by a copy of test results, that the material has been sampled, tested, and inspected in accordance with the provisions of these specifications. Each certification shall be signed by an authorized agent of the manufacturer or the supplier.

Rejection

24. Each length of pipe that develops injurious defects during shop working or application operations shall be rejected, and the manufacturer shall be notified.

APPENDIX

A system of standard pipe sizes has been approved by the American Standards Association as American Standard for Wrought-Steel and Wrought-Iron Pipe (ASA No. B 36.10–1959) whose Table 3 (Dimensions and Weights of Welded Wrought-Iron Pipe) is reprinted below. This table is published here as information only. Copies of this American Standard are available from The American Society of Mechanical Engineers, 345 East 47th St., New York 17, N. Y.

TABLE III.—DIMENSIONS AND WEIGHTS OF WELDED WROUGHT-IRON PIPE.[a,b]

Nominal Pipe Size and Outside Diameter, in.	Wall Thickness, in.[c,d]	Plain End Weight, lb per ft	Identification			Nominal Pipe Size and Outside Diameter, in.	Wall Thickness, in.[c,d]	Plain End Weight, lb per ft	Identification		
			API Standard	Standard, X-Strong, XX-Strong	Schedule Number				API Standard	Standard, X-Strong, XX-Strong	Schedule Number
⅛ (0.405)	0.069	0.24	5L	STD	40	4 (4.500)	0.242	10.79	5L	STD	40
	0.096	0.31	5L	XS	80		0.344	14.98	5L	XS	80
¼ (0.540)	0.090	0.42	5L	STD	40		0.690	27.54	5L	XXS	
	0.124	0.54	5L	XS	80	5 (5.563)	0.263	14.61	5L	STD	40
⅜ (0.675)	0.093	0.57	5L	STD	40		0.383	20.78	5L	XS	80
	0.129	0.74	5L	XS	80		0.768	38.55	5L	XXS	
½ (0.840)	0.111	0.85	5L	STD	40	6 (6.625)	0.286	18.97	5L	STD	40
	0.151	1.09	5L	XS	80		0.441	28.57	5L	XS	80
	0.307	1.71	5L	XXS			0.884	53.16	5L	XXS	
¾ (1.050)	0.115	1.13	5L	STD	40	8 (8.625)	0.283	24.70	5L		30
	0.157	1.47	5L	XS	80		0.329	28.55	5L		40
	0.318	2.44	5L	XXS			0.511	43.39	5L	XS	80
							0.895	72.42	5L	XXS	
1 (1.315)	0.136	1.68	5L	STD	40	10 (10.750)	0.284	31.20	5L		
	0.183	2.17	5L	XS	80		0.313	34.24	5L		30
	0.369	3.66	5L	XXS			0.372	40.48	5L		40
							0.510	54.74	5L	XS	60
1¼ (1.660)	0.143	2.27	5L	STD	40	12 (12.750)	0.336	48.77	5L		30
	0.196	3.00	5L	XS	80		0.383	49.56	5L		
	0.393	5.21	5L	XXS			0.510	65.42	5L	XS	
1½ (1.900)	0.148	2.72	5L	STD	40	14 (14.000)	0.383	54.57	5L	STD	30
	0.204	3.63	5L	XS	80		0.510	72.09	5L	XS	
	0.411	6.41	5L	XXS							
2 (2.375)	0.157	3.65	5L	STD	40	16 (16.000)	0.383	62.58	5L	STD	30
	0.223	5.02	5L	XS	80		0.510	82.77	5L	XS	40
	0.447	9.03	5L	XXS							
						18 (18.000)	0.383	70.59	5L	STD	
2½ (2.875)	0.207	5.79	5L	STD	40		0.510	93.45	5L	XS	
	0.282	7.66	5L	XS	80						
	0.567	13.70	5L	XXS		20 (20.000)	0.383	78.60	5L	STD	20
							0.510	104.13	5L	XS	30
3 (3.500)	0.221	7.58	5L	STD	40	24 (24.000)	0.383	94.62	5L	STD	20
	0.306	10.25	5L	XS	80		0.510	125.49	5L	XS	
	0.615	18.58	5L	XXS							
3½ (4.000)	0.231	9.10	5L	STD	40						
	0.325	12.51	5L	XS	80						
	0.651	22.85		XXS							

[a] The manufacture of pipe, in the nominal sizes of ⅛ to 12 in. inclusive, proceeds on the basis of a standardized outside diameter and the standardized weight per foot for each size of pipe. The wall thicknesses and the internal diameters, of this range of pipe sizes, are calculated values.

[b] The manufacture of pipe, in the nominal sizes of 14 in. in outside diameter and larger, proceeds on the basis of an outside diameter corresponding to the nominal size, and on the basis of a selected wall thickness, usually expressed in fractional parts of an inch. The weight per foot of this pipe is a calculated value.

[c] For tolerances on wall thicknesses see appropriate material specifications.

[d] The thicknesses of all of the sizes shown in this table are slightly greater than those of corresponding sizes for steel pipe, to compensate for the difference in weights per cubic foot of wrought-steel and wrought-iron.

SPECIFICATION FOR SEAMLESS CARBON STEEL AND OPEN HEARTH IRON BOILER TUBES

SA-83

(IDENTICAL WITH ASTM SPECIFICATION A 83-61T EXCEPT FOR EDITORIAL CORRECTIONS)

Scope

1. (*a*) This specification covers seamless carbon-steel and open-hearth iron boiler tubes and boiler flues, including safe ends, arch and stay tubes, and seamless superheater and small boiler tubes.

(*b*) This specification covers tubes ½ to 6 in., inclusive, in outside diameter and 0.035 to 0.320 in., inclusive, in minimum wall thickness.

(*c*) The purchaser shall specify in the order the outside diameter, minimum wall thickness, and grade desired. The inside diameter shall not be specified.

NOTE.—Tubing smaller in outside diameter and having a thinner wall than indicated in this specification is available. These smaller sizes may require different mechanical and manipulating tests which should be a matter of agreement between the manufacturer and the purchaser.

General Requirements

2. Material furnished under this specification shall conform to the applicable requirements of the current edition of the Specification for General Requirements for Carbon, Ferritic Alloy, and Austenitic Alloy Steel Tubes (ASTM Designation: A 450), unless otherwise provided herein.

Process

3. The steel shall be made by one or more of the following processes: open hearth, basic oxygen, or electric furnace. The open-hearth iron shall be made by the open-hearth process.

Manufacture

4. Tubes shall be made by the seamless process and shall be either hot-finished or cold-drawn, as specified.

Heat Treatment

5. Cold-drawn tubes shall be annealed "dead soft" after the final pass. Hot-finished tubes need not be annealed unless specified by the purchaser.

Chemical Composition

6. The steel or iron shall conform to the requirements as to chemical composition prescribed in Table I.

Check Analysis

7. (*a*) An analysis of two tubes from each lot of 250 tubes or fraction thereof, and from each lot of 2000 ft or fraction thereof, of safe-end material may be made by the purchaser. The chemical composition thus determined shall conform to the requirements specified.

(*b*) If the analysis of either tube does not conform to the requirements specified, an analysis of two additional tubes from the same lot shall be made, each of which shall conform to the requirements specified.

Crush Test

8. When required by the purchaser, crushing tests shall be made on sections of tube 2½ in. in length which shall stand crushing longitudinally, without cracking or splitting, as shown in the following table. For tubing less than 1 in. in outside diameter, the length of the specimen shall be 2½ times the outside diameter of the tube. Slight surface checks shall not be cause for rejection.

Wall Thickness of Tubes, in.	Height of Crushed Section, in.
	Grades A and B Tubes
0.135 and under	¾, or until outside folds are in contact
Over 0.135	1¼

Mechanical Tests Required

9. (*a*) *Flattening Test.*—One flattening test shall be made on specimens from each of two tubes from each lot of 250 tubes or fraction thereof, and from each

TABLE I.—CHEMICAL REQUIREMENTS.

	Grade A Low-Carbon Steel	Grade B Open-Hearth Iron	Alternate Grade B Open-Hearth Iron[b]
Carbon, per cent	0.06 to 0.18	0.08 max	0.05 max
Manganese, per cent	0.27 to 0.63	0.03 max	0.35 max
Phosphorus, max, per cent	0.048	0.020	0.020
Sulfur, max, per cent	0.058	0.045	0.045
Molybdenum, per cent	...	...	[c]
Copper, per cent	[a]	...	[c]

[a] When grade A tubes are specified with copper content, the copper range shall be 0.20 to 0.35 per cent on ladle analysis and 0.18 to 0.35 per cent on check analysis.

[b] If desired, alternate grade B (open-hearth iron) may be specified conforming to the chemical requirements given above. This alternate grade B shall meet all the tests and other requirements now specified for grade B.

[c] Alternate grade B may be specified as shown, or with a minimum copper content of 0.20 per cent, or with a molybdenum content of 0.05 to 0.15 per cent and a minimum copper content of 0.40 per cent.

2000 ft or fraction thereof of safe-end material.

(*b*) *Flange Test.*—For tubes having a wall thickness (actual mean wall) less than 10 per cent of the outside diameter, and provided the thickness does not exceed 0.200 in., one test shall be made on specimens from each of two tubes from each lot of 250 tubes or fraction thereof, and from each 2000 ft or fraction thereof of safe-end material. For tubes other than specified in Section 1(*b*), the flange test shall not be required.

(*c*) *Crush Test.*—When required by the purchaser, one crush test shall be made on specimens from each of two tubes from each lot of 250 tubes or fraction thereof, and from each 2000 ft of fraction thereof of safe-end material.

(*d*) *Hydrostatic Test.*—Each tube shall be subjected to the hydrostatic pressure test.

Forming Operations

10. Tubes when inserted in the boiler shall stand expanding and bending without showing cracks or flaws. Superheater tubes when properly manipulated shall stand all forging, welding, and bending operations necessary for application without developing defects.

Finish

11. Finished tubes shall be reasonably straight and have smooth ends free from burrs. They shall be free from injurious defects and shall have a workmanlike finish.

Marking

12. In addition to the marking prescribed in Specification A 450 the marking shall include whether the tube is made of steel or open-hearth iron, and whether it is hot-finished or cold-drawn.

SPECIFICATION FOR STAYBOLT WROUGHT IRON, SOLID

SA-84

(IDENTICAL WITH ASTM SPECIFICATION A 84-60T)

Scope

1. These specifications cover wrought iron for solid staybolts, round bars only.

Manufacture

2. The bars shall be rolled from a slab pile or box pile made from all pig-puddled, knobbled charcoal, or processed wrought iron.[4] The original muck bars shall be piled, rolled, repiled, and rerolled. The component parts of the slab pile or box pile shall be free from any admixture of iron scrap or steel.

Definitions of Terms

3. (*a*) *Slab Pile.*—A slab pile is a pile built up wholly of flat bars of iron, all bars running the full length of the pile.

(*b*) *Box Pile.*—In manufacturing wrought-iron bars, a box pile is a pile, the outside of which is formed of flat bars and the interior of a number of small bars, all bars running the full length of the pile.

Chemical Composition

4. The iron shall conform to the following requirement as to chemical composition:

Manganese, max., per cent	0.06

Check Analysis

5. An analysis may be made by the purchaser from a broken tension test specimen representing each lot as specified in Section 10. Drillings for analysis shall be so taken as to represent the entire cross-section of the specimen The chemical composition thus determined shall conform to the requirement specified in Section 4.

[4] Wrought iron is defined as follows

Wrought Iron.—A ferrous material, aggregated from a solidifying mass of pasty particles of highly refined metallic iron with which, without subsequent fusion, is incorporated a minutely and uniformly distributed quantity of slag.

Tensile Properties

6. (*a*) The material shall conform to the following requirements as to tensile properties:

Tensile strength, psi	47 000 to 52 000[a]
Yield point, min., psi	0.60 tens. str.
Elongation in 8 in., min., per cent	30[b]
Reduction of area, min., per cent	48[a]

[a] See Paragraph (*c*).
[b] See Paragraph (*d*).

(*b*) The yield point shall be determined by the drop of the beam or halt in the gage of the testing machine. The speed of the crosshead of the machine until the yield point is reached shall not exceed $\frac{3}{4}$ in. per min. After passing the yield point, the speed of the crosshead shall not exceed 3 in. per min.

(*c*) For material over $1\frac{1}{2}$ sq. in. in cross-sectional area, a reduction of 250 psi. from the minimum tensile strength specified in Paragraph (*a*) and a reduction of 3 per cent from the reduction of area specified in Paragraph (*a*) will be permitted for each additional 1 sq. in., and a proportionate amount of reduction for fractional parts thereof; provided that the tensile strength shall not be less than 46,000 psi. and the reduction of area not less than 40 per cent.

(*d*) For material $\frac{7}{8}$ in. down to and including $1\frac{1}{8}$ in. in diameter, the elongation shall be not less than 28 per cent. For material $\frac{7}{8}$ in. and under in diameter, the elongation shall be not less than 25 per cent.

Bending Properties

7. (*a*) *Cold-Bend Tests.*—The bend test specimen shall stand being bent cold through 180 deg. A second similar 180-deg bend shall be made on the same sample on a plane 90 deg to the plane of the first bend. The specimen shall withstand both bends without fracture on the outside of the bent portions.

(*b*) *Nick-Bend Tests.*—At the option of the purchaser, the following test shall be made: The test specimen, when nicked 25 per cent around, with a tool having a 60-deg. cutting edge, to a depth of not less than 8 nor more than 16 per cent of the diameter of the specimen and broken slowly, shall show clean fibers, free from crystallization.

(*c*) Bend tests may be made by pressure or by blows.

Etch Test

8. The cross-section of the test specimen shall be ground or polished, and etched[5] for a sufficient period to develop the structure. This test shall show the material to be free from steel and to have been rolled from a slab pile or box pile.

Test Specimens

9. All test specimens shall be of the full section of the material as rolled.

Number of Tests

10. (*a*) Bars of each size shall be sorted into lots of 100 each, except as specified in Paragraph (*b*). Two bars shall be selected at random from each lot or fraction thereof, and tested as specified in Sections 6 and 7, but only one of these bars shall be tested as specified in Section 8.

(*b*) When small lots of different sizes are to be tested, the bars shall be grouped into lots of 50 or fraction thereof, without regard to size. One bar representing each lot of 50 bars or fraction thereof shall be tested as specified in Sections 6, 7, and 8.

[5] A solution of two parts water, one part concentrated hydrochloric acid, and one part concentrated sulfuric acid is recommended for the etch test.

(c) If any of the specimens originally selected to represent a lot of material contains surface defects not visible before testing but visible after testing, or if a tension test specimen fails to conform to the requirements specified in Section 6 and breaks outside the middle third of the gage length, as indicated by scribe scratches marked on the specimen before testing, the individual specimen shall be rejected, and one retest from a different bar or bolt will be allowed.

Permissible Variations in Size

11. The bars shall be truly round within 0.01 in. The diameter shall be not less than 0.005 in. over nor more than 0.020 in. over the specified diameter.

Finish

12. The bars shall be smoothly rolled and free from slivers, depressions, crop ends, seams, and evidences of being burnt.

Marking

13. The bars shall be stamped or otherwise marked with the name or brand of the manufacturer.

Inspection

14. (a) The inspector representing the purchaser shall have free entry, at all times while work on the contract of the purchaser is being performed, to all parts of the manufacturer's works which concern the manufacture of the material ordered. The manufacturer shall afford the inspector, without charge, all reasonable facilities to satisfy him that the material is being furnished in accordance with these specifications. All tests (except check analysis) and inspection shall be made at the place of manufacture prior to shipment, unless otherwise specified, and shall be so conducted as not to interfere unnecessarily with the operation of the works.

(b) The purchaser may make the tests to govern the acceptance or rejection of the material in his own laboratory or elsewhere. Such tests, however, shall be made at the expense of the purchaser.

(c) In lieu of inspection by the purchaser's representative, when agreed upon in writing by the purchaser and the supplier, a certification shall be made the basis of acceptance of the material. This shall consist of manufacturer's test reports, or a statement by the supplier, accompanied by a copy of the test results, that the material has been sampled, tested, and inspected in accordance with the provisions of this specification. Each certification shall be signed by an authorized agent of the manufacturer or of the supplier.

Rejection

15. (a) If either of the test bars selected to represent a lot does not conform to the requirements specified, the lot will be rejected.

(b) Material which will not take a clean, sharp thread, with dies in fair condition, or which develops defects in forging or machining, will be rejected, and the manufacturer shall be notified.

(c) Unless other specified, any rejection based on tests made in accordance with Section 14 (b) shall be reported to the manufacturer within five working days from the receipt of samples by the purchaser.

Rehearing

16. Samples tested in accordance with Section 14 (b) that represent rejected material shall be preserved for two weeks from the date of the test report. In case of dissatisfaction with the results of the tests, the manufacturer may make claim for a rehearing within that time.

SPECIFICATION FOR FORGED OR ROLLED STEEL PIPE FLANGES, FORGED FITTINGS, AND VALVES AND PARTS FOR HIGH-TEMPERATURE SERVICE

SA-105

(IDENTICAL WITH ASTM SPECIFICATION A 105-61T)

Scope

1. (a) These specifications cover forged or rolled steel pipe flanges, forged fittings, and valves and parts for high-temperature service (Note). The term "forgings" used in these specifications shall be understood to cover one or all of the products mentioned above, either forged or rolled.

(b) Two grades of material are covered, designated grades I and II, respectively, and are classified in accordance with their mechanical properties as specified in Section 9 (a).

Process

2. The steel may be made by either or both of the following processes: open-hearth or electric-furnace.

Discard

3. A sufficient discard shall be made from each ingot to secure freedom from injurious piping and undue segregation.

Manufacturing Practice

4. (a) Material for forgings shall consist of ingots or blooms, billets, slabs, or bars either forged or rolled from an ingot, and cut to the required length by a suitable process.

(b) The material shall be forged by hammering, pressing, rolling, extruding, or upsetting and shall be brought as nearly as practicable to the finished shape and size by hot working and shall be so processed as to cause metal flow during the hot working operation in the direction most favorable for resisting the stresses encountered in service.

(c) When specified in the order, a sample forging may be sectioned and etched to show flow lines and the condition as regards internal imperfections.

TABLE I.—CHEMICAL REQUIREMENTS.

	Grade I	Grade II
Carbon, max, per cent	0.35	0.35
Manganese, max, per cent	0.90	0.90
Phosphorus, max, per cent	0.05	0.05
Silicon, max, per cent	[a]	[a]
Sulfur, max, per cent	0.05	0.05

[a] It may be necessary to add silicon to the composition for grade II and for the heavier thicknesses of grade I flanges in order to meet the required tensile properties. The silicon content shall not exceed 0.35 per cent.

In such cases, the question of acceptable and unacceptable character of metal flow shall be a subject for agreement between the manufacturer and the purchaser.

(d) When specified in the order, the manufacturer shall submit for approval of the purchaser a sketch showing the shape of the rough forging before machining.

(e) Forgings intended for application to pressure vessels may be repair welded provided the welding is performed in accordance with all the requirements of Part UF of Section VIII of the ASME Boiler and Pressure Vessel Code, and the repair welding is approved by the purchaser.

Heat Treatment

5. (a) Grades I and II flanges, forged fittings, valves and parts shall be heat treated. Heat treatment may consist of annealing or normalizing.

(b) *Annealing.*—The procedure for annealing shall consist in allowing the forgings, immediately after forging or rolling, to cool to a temperature below the critical range, under suitable conditions to prevent injuries by too rapid cooling. They shall then be uniformly reheated to the proper temperature to refine the grain (a group thus reheated being known as an "annealing charge") and allowed to cool uniformly in the furnace.

(c) *Normalizing.*—The procedure for normalizing shall consist in allowing the forgings, immediately after forging or rolling, to cool to a temperature below the critical range, under suitable conditions to prevent injuries by too rapid cooling. They shall then be uniformly reheated to the proper temperature to refine the grain (a group thus reheated being known as a "normalizing charge") and allowed to cool in still air.

TABLE II.—TENSILE REQUIREMENTS.

	Grade I	Grade II
Tensile strength, min, psi	60 000	70 000
Yield point, min, psi	30 000	36 000
Elongation in 2 in., min, per cent	25	22
Reduction of area, min, per cent	38	30

(d) No forgings that have been quenched in any liquid medium shall be offered under these specifications, except by agreement between the manufacturer and the purchaser.

Chemical Composition

6. The steel shall conform to the requirements as to chemical composition prescribed in Table I.

Ladle Analysis

7. An analysis of each heat of steel shall be made by the manufacturer to determine the percentages of the elements specified in Section 6.

Check Analysis

8. An analysis may be made by the purchaser from one forging representing each heat. Samples for analysis shall be taken not less than ¼ in. below the surface or from tension test specimens. The chemical composition thus determined shall conform to the requirements specified in Section 6, except that the phosphorus and sulfur content may each be 0.055 per cent.

Tensile Properties

9. (*a*) The material shall conform to the requirements as to tensile properties prescribed in Table II.

(*b*) The yield point shall be determined by the drop of the beam or halt in the gage of the testing machine, or by the use of dividers, at a crosshead speed not to exceed ½ in. per min. The tensile strength shall be determined at a speed of head not to exceed 1½ in. per min.

Test Specimens

10. (*a*) The tension test specimens taken from the forgings, billets, or bars shall be machined to the form and dimensions of the standard 2-in. gage length tension test specimen shown in Fig. 6 of the Methods and Definitions for Mechanical Testing of Steel Products (ASTM Designation: A 370), except as specified in Paragraph (*b*).

(*b*) In the case of small sections which will not permit of taking the standard test specimen specified in Paragraph (*a*), the tension test specimen shall be as large as feasible and its dimensions shall be proportional to those shown in Fig. 6 of Methods A 370. The gage length for measuring elongation shall be four times the diameter of the specimen.[4]

(*c*) For the purpose of making tension tests, the forging manufacturer shall supply suitable test specimens from the flange or, at his option, furnish test blanks prepared from the billets or forging bar entering into the finished product, provided such test blank has undergone approximately the same working and heat treatment as the finished product.

Number of Tests

11. (*a*) One tension test shall be made from each annealing or normalizing charge. If more than one heat is represented in an annealing or normalizing charge, a test shall be made from each heat.

(*b*) If any test specimen shows defective machining or develops flaws, it may be discarded and another specimen substituted.

Retests

12. If any of the results of the mechanical tests of any test lot do not conform to the requirements specified, the manufacturer may retest such lots but not more than twice, except with the approval of the purchaser on the basis of satisfactory metallurgical evidence that the cause of the failure is curable and the quality of the material is satisfactory. Retests shall be made as specified in Section 11 (*a*).

Workmanship

13. The forgings shall conform to the sizes and shapes specified by the purchaser

Finish

14. The forgings shall be free from injurious defects and shall have a workmanlike finish.

Marking

15. Identification marks consisting of the manufacturer's symbol or name, designation of service rating, the designation A 105—I or A 105—II to indicate the grade of material, and the size shall be legibly stamped on each forging in accordance with the Standard Marking Sysetm for Valves, Fittings, Flanges, and Unions (SP-25-1960) of the Manufacturer's Standardization Society of the Valve and Fittings Industry, and in such position as not to injure the usefulness of the forging.

Inspection

16. (*a*) The inspector representing the purchaser shall have free entry, at all times while work on the contract of the purchaser is being performed, to all parts of the manufacturer's works that concern the manufacture of the material ordered. The manufacturer shall afford the inspector, without charge, all reasonable facilities to satisfy him that the material is being furnished in accordance with these specifications. All tests (except check analysis) and inspection shall be made at the place of manufacture prior to shipment, unless otherwise specified, and shall be so conducted as not to interfere unnecessarily with the operation of the works.

(*b*) *Certification.*—Unless otherwise specified in the order, a certification that the material conforms to the requirements of these specifications shall be the basis of acceptance of the material.

Rejection

17. (*a*) Unless otherwise specified, any rejection based on tests made in accordance with Section 8 shall be reported to the manufacturer within twelve working days from the receipt of samples by the purchaser.

(*b*) Material that shows injurious defects while being finished shall be rejected.

Rehearing

18. Samples tested in accordance with Section 8 that represent rejected material shall be preserved for two weeks from the date of the test report. In case of dissatisfaction with the results of the tests, the manufacturer may make claim for a rehearing within that time.

[4] These requirements are in accordance with the provisions of Section 8 of the Methods of Tension Testing of Metallic Materials (ASTM Designation: E 8).

NOTE.—Reference may be made to the dimensional standards for hydraulic pressure ratings and corresponding temperatures formulated by the Sectional Committee on Standardization of Pipe Flanges and Fittings, under the procedure of the American Standards Association, ASA Project B16 and more specifically to the American Standard for Steel Pipe Flanges and Flanged Fittings (ASA No.: B16.5-1961). Copies of the American Standard are obtainable from The American Society of Mechanical Engineers, 345 East 47th St., New York 17, N. Y.

EXPLANATORY NOTE

SPECIFICATION FOR SEAMLESS CARBON-STEEL PIPE FOR HIGH-TEMPERATURE SERVICE

SA-106

(IDENTICAL WITH ASTM SPECIFICATION A 106-61T)

Scope

1. (*a*) These specifications cover seamless carbon-steel pipe for high-temperature service (see Explanatory Note 1). Pipe ordered under these specifications is nominal (average) wall and shall be suitable for bending, flanging, and similar forming operations (see Explanatory Note 2).

(*b*) Supplementary requirements (Paragraphs S1 to S6) of an optional nature are provided for seamless pipe intended for use in central stations having steam service pressures of 400 psi and over and high temperatures or other applications where a superior grade of pipe is required. These supplementary requirements call for additional tests to be made at the expense of the purchaser, and when desired shall be so stated in the order.

Process

2. (*a*) The steel shall be killed steel made by either or both of the following processes: open-hearth or electric furnace.

(*b*) Pipe 1½ in. and under in nominal diameter may be either hot finished or cold drawn and annealed.

(*c*) Unless otherwise specified, pipe 2 in. and over in nominal diameter shall be furnished hot finished. When agreed upon between the manufacturer and the purchaser, cold-drawn and annealed pipe may be furnished.

Chemical Composition

3. The steel shall conform to the chemical requirements prescribed in Table I.

Ladle Analysis

4. An analysis of each heat of steel shall be made by the steel manufacturer to determine the percentages of the elements specified in Section 3. The chemical composition thus determined, or that determined from a check analysis made by the manufacturer, if the latter has not manufactured the steel, shall be reported to the purchaser or his representative, and shall conform to the requirements specified in Section 3.

Check Analysis

5. (*a*) At the request of the purchaser, analyses of two pipes from each lot[3] of 400 lengths or fraction thereof, of each size 2 in. up to, but not including, 6 in., and from each lot[3] of 200 lengths or fraction thereof of each size 6 in. and over, shall be made by the manufacturer from the finished pipe. Samples for chemical analysis, except for spectrochemical analysis, shall be taken in accordance with the Method of Sampling Steel, Cast Iron, Open-Hearth Iron, and Wrought Iron for Determination of Chemical Composition (ASTM Designation: E 59). The chemical composition thus determined shall conform to the requirements specified in Section 3.

(*b*) If the analysis of one of the tests specified in Paragraph (*a*) does not conform to the requirements specified in Section 3, analyses shall be made on additional pipes of double the original number from the same lot, each of which shall conform to requirements specified.

Tensile Properties

6. (*a*) The material shall conform to the requirements as to tensile properties prescribed in Table II.

(*b*) The yield point shall be determined by the drop of the beam, by the halt in the gage of the testing machine, by the use of dividers, or by other approved methods. When a definite yield point is not exhibited, the yield strength corresponding to a permanent offset of 0.2 per cent of the gage length of the specimen, or to a total extension of 0.5 per cent of the gage length under load shall be determined.

Bending Properties

7. For pipe 2 in. and under in nominal diameter, a sufficient length of pipe shall stand being bent cold through 90 deg around a cylindrical mandrel, the diameter of which is twelve times the nominal diameter of the pipe, without developing cracks. When ordered for close coiling

TABLE I.—CHEMICAL REQUIREMENTS

	Grade A	Grade B	Grade C[a]
Carbon, max, per cent	0.25	0.30	0.35
Manganese, per cent	0.27 to 0.93	0.29 to 1.06	0.29 to 1.06
Phosphorus, max, per cent	0.048	0.048	0.048
Sulfur, max, per cent	0.058	0.058	0.058
Silicon, min, per cent	0.10	0.10	0.10

[a] Grade C is a special product supplied only on agreement between the manufacturer and the purchaser.

[3] A lot shall consist of the number of lengths specified in Sections 5 and 11, of the same size and wall thickness from any one heat of steel.

(see Explanatory Note 2), the pipe shall stand being bent cold through 180 deg around a cylindrical mandrel, the diameter of which is eight times the nominal diameter of the pipe, without failure.

Flattening Tests

8. For pipe over 2 in. in nominal diameter a section of pipe not less than 2½ in. in length shall be flattened cold between parallel plates until the opposite walls of the pipe meet. No cracks or breaks in the metal shall occur until the distance between the plates is less than that calculated for the value of "*H*" by the following formula:

$$H = \frac{(1 + e)t}{e + t/D}$$

where:

H = distance between flattening plates in inches,[5]
e = deformation per unit length (constant for a given grade of steel, 0.08 for grade A and 0.07 for grades B and C),
t = nominal wall thickness of pipe in inches, and
D = actual outside diameter of pipe in inches.

Evidence of laminations or burnt material shall not develop during the entire flattening process.

Hydrostatic Test

9. (*a*) Unless otherwise agreed upon between the manufacturer and the purchaser, each length of pipe shall be tested by the manufacturer to a hydrostatic pressure which will produce in the pipe wall a stress of 60 per cent of the minimum specified yield point at room temperature. This pressure shall be determined by the following formula:

$$P = \frac{2St}{D}$$

where:

P = minimum hydrostatic test pressure in pounds per square inch,
S = 0.60 times the minimum specified yield point at room temperature in pounds per square inch,
t = nominal wall thickness in inches, and
D = outside diameter in inches.

[5] The "*H*" values have been calculated for sizes from 2½ to 24 in., incl, and are shown in Table V (See Appendix I) of these specifications.

TABLE II.—TENSILE REQUIREMENTS.

	Grade A (See Explanatory Note 2)		Grade B		Grade C	
Tensile strength, min, psi	48 000		60 000		70 000	
Yield point, min, psi	30 000		35 000		40 000	
	Longitudinal	Transverse	Longitudinal	Transverse	Longitudinal	Transverse
Elongation in 2 in., min, per cent:						
Basic minimum elongation for walls 5/16 in. and over in thickness, strip tests, and for all small sizes tested in full section	35	25	30	16.5	30	16.5
When standard round 2-in. gage length test specimen is used	28	20	22	12	20	12
For strip tests, the width of the gage section shall be 1½ in. and a deduction for each 1/32-in. decrease in wall thickness below 5/16 in. from the basic minimum elongation of the following percentage	1.75[a]	1.25[a]	1.50[a]	1.00[a]	1.50[a]	1.00[a]

[a] The following table gives the computed minimum values:

Wall Thickness, in.	Elongation in 2 in. min, per cent			
	Grade A		Grades B and C	
	Longitudinal	Transverse	Longitudinal	Transverse
5/16 (0.312)	35.00	25.00	30.00	16.50
9/32 (0.281)	33.25	23.75	28.50	15.50
1/4 (0.250)	31.50	22.50	27.00	14.50
7/32 (0.219)	29.75	...	25.50	...
3/16 (0.188)	28.00	...	24.00	...
5/32 (0.156)	26.25	...	22.50	...
1/8 (0.125)	24.50	...	21.00	...
3/32 (0.094)	22.75	...	19.50	...
1/16 (0.062)	21.00	...	18.00	...

NOTE.—The above table gives the computed minimum elongation values for each 1/32-in. decrease in wall thickness. Where the wall thickness lies between two values shown above, the minimum elongation value is determined by the following formula:

Grade	Direction of Test	Formula
A	Longitudinal	$E = 56t + 17.50$
A	Transverse	$E = 40t + 12.50$
B and C	Longitudinal	$E = 48t + 15.00$
B and C	Transverse	$E = 32t + 6.50$

where:
E = elongation in 2 in. in per cent, and
t = actual thickness of specimen, in inches.

(*b*) The maximum hydrostatic test pressure shall not exceed 2500 psi for nominal sizes 3 in. and under, or 2800 psi for all nominal sizes over 3 in. The hydrostatic pressure shall be maintained for not less than 5 sec.

NOTE.—When requested by the purchaser and so stated in the order, pipe in sizes 14 in. in nominal diameter and smaller shall be tested to one and one half times the specified working pressure, provided the fiber stress corresponding to those test pressures does not exceed 60 per cent the minimum specified yield point of the material, as determined by the above formula. When one and one-half times the working pressure exceeds 2800 psi, the hydrostatic test pressure shall be a matter of agreement between the purchaser and the manufacturer.

Test Specimens and Methods of Testing

10. (*a*) The test specimens and the tests required by these specifications shall conform to those described in the Methods and Definitions for the Mechanical Testing of Steel Products (ASTM Designation: A 370).

(*b*) Specimens cut either longitudinally or transversely shall be acceptable for the tension test.

(*c*) Test specimens for the bend and flattening tests shall consist of sections cut from a pipe. Specimens for flattening tests shall be smooth on the ends and free from burrs, except when made on crop ends.

(*d*) All routine check tests shall be made at room temperature.

Number of Tests

11. (*a*) One of either of the tests specified in Section 6 shall be made on one length of pipe from each lot[3] of 400 lengths or fraction thereof of each size under 6 in., and from each lot[3] of 200 lengths or fraction thereof of each size 6 in. and over.

(*b*) For pipe 2 in. and under in nominal diameter, the bend test specified in Section 7 shall be made on one pipe from each lot[3] of 400 lengths or fraction thereof of each size.

(*c*) The flattening test specified in Section 8 shall be made on one length of pipe from each lot[3] of 400 lengths or fraction thereof of each size over 2 in., up to but not including 6 in., and from each lot[3] of 200 lengths or fraction thereof, of each size 6 in. and over.

(*d*) Each length of pipe shall be subjected to the hydrostatic test specified in Section 9.

(*e*) If any test specimen shows defective machining or develops flaws, it may be discarded and another specimen substituted.

(*f*) If the percentage of elongation of any tension test specimen is less than that prescribed in Table II and any part of the fracture is more than ¾ in. from the center of the gage length of a 2-in. specimen as indicated by scribe scratches marked on the specimen before testing, a retest shall be allowed. If a specimen breaks in an inside or outside surface flaw, a retest shall be allowed.

Retests

12. (*a*) If the results of any mechanical tests of any lot[3] do not conform to the requirements specified in Sections 6, 7, and 8, retests shall be made on additional pipes of double the original number from the same lot, each of which shall conform to the requirements specified.

(*b*) Should a crop end of a finished pipe fail in the flattening test, one retest may be made from the failed end. Pipe may be normalized either before or after the first test, but pipe shall be subjected to only two normalizing treatments.

TABLE III.—DIMENSIONS OF WELDED AND SEAMLESS STEEL PIPE.[a]

NOTE 1.—Thicknesses shown in boldface type in Schedules 30 and 40 are identical with thicknesses for "standard-weight" pipe in former lists; those in Schedules 60 and 80 are identical with thicknesses for "extra-strong" pipe in former lists.

NOTE 2.—The decimal thicknesses for the respective pipe sizes represent their nominal or average wall dimensions.

NOTE 3.—Some of the larger, heavier wall sections are beyond the capabilities of seamless mill production and must be obtained from turned and bored billets or other sources.

Nominal Pipe Size, in.	Outside Diameter, in.	Nominal Wall Thickness, in.									
		Schedule Number									
		10	20	30	40	60	80	100	120	140	160
1/8	0.405				**0.068**		**0.095**				
1/4	0.540				**0.088**		**0.119**				
3/8	0.675				**0.091**		**0.126**				
1/2	0.840				**0.109**		**0.147**				0.187
3/4	1.050				**0.113**		**0.154**				0.218
1	1.315				**0.133**		**0.179**				0.250
1¼	1.660				**0.140**		**0.191**				0.250
1½	1.900				**0.145**		**0.200**				0.281
2	2.375				**0.154**		**0.218**				0.343
2½	2.875				**0.203**		**0.276**				0.375
3	3.5				**0.216**		**0.300**				0.438
3½	4.0				**0.226**		**0.318**				
4	4.5				**0.237**		**0.337**		0.438		0.531
5	5.563				**0.258**		**0.375**		0.500		0.625
6	6.625				**0.280**		**0.432**		0.562		0.718
8	8.625		0.250	**0.277**	**0.322**	0.406	**0.500**	0.593	0.718	0.812	0.906
10	10.75		0.250	**0.307**	**0.365**	**0.500**	0.593	0.718	0.843	1.000	1.125
12	12.75		0.250	**0.330**	0.406	0.562	0.687	0.843	1.000	1.125	1.312
14 OD	14.0	0.250	0.312	0.375	0.438	0.593	0.750	0.937	1.093	1.250	1.406
16 OD	16.0	0.250	0.312	0.375	0.500	0.656	0.843	1.031	1.218	1.438	1.593
18 OD	18.0	0.250	0.312	0.438	0.562	0.750	0.937	1.156	1.375	1.562	1.781
20 OD	20.0	0.250	0.375	0.500	0.593	0.812	1.031	1.281	1.500	1.750	1.968
24 OD	24.0	0.250	0.375	0.562	0.687	0.968	1.218	1.531	1.812	2.062	2.343

[a] See Explanatory Note 3.

Dimensions

13. (*a*) The nominal wall thicknesses for pipe of various diameters are prescribed in Table III.

(*b*) Nipples shall be cut from pipe of the same dimensions and quality described in these specifications.

Permissible Variations in Weight and Dimensions

14. (*a*) *Weight.*—The weight of any length of pipe shall not vary more than 6.5 per cent over and 3.5 per cent under that specified for pipe of schedules 10 to 120, incl, nor more than 10 per cent over and 3.5 per cent under that specified for pipe heavier than schedule 120 (Note). Unless otherwise agreed upon between the manufacturer and the purchaser, pipe in sizes 4 in. and smaller may be weighed in convenient lots; pipe in sizes larger than 4 in. shall be weighed separately.

NOTE.—For weights corresponding to the thicknesses prescribed in Table III, also for the specifications for pipe approved by the American Standards Association, reference should be made to the American Standard for Wrought Steel and Wrought Iron Pipe (ASA No.: B 36.10—1959). Copies of this American Standard are available from The American Society of Mechanical Engineers, 345 East 47th St., New York 17, N. Y.

(*b*) *Diameter.*—Variations in outside diameter shall not exceed those specified in Table IV.

(*c*) *Thickness.*—The minimum wall thickness at any point shall not be more

than 12.5 per cent under the nominal wall thickness specified.

NOTE.—The minimum wall thickness on inspection is shown in Table VI (Appendix II).

Lengths

15. Pipe lengths shall be in accordance with the following regular practice:

(*a*) The lengths required shall be specified in the order, and

(*b*) No jointers are permitted unless otherwise specified.

(*c*) If definite lengths are not required, pipe may be ordered in single random lengths of 16 to 22 ft with 5 per cent

TABLE IV.—VARIATIONS IN OUTSIDE DIAMETER.

Nominal Pipe Size, in.	Permissible Variations in Outside Diameter, in.	
	Over	Under
⅛ to 1½, incl.	1/64 (0.015)	1/32 (0.031)
Over 1½ to 4, incl.	1/32 (0.031)	1/32 (0.031)
Over 4 to 8, incl.	1/16 (0.062)	1/32 (0.031)
Over 8 to 18, incl.	3/32 (0.093)	1/32 (0.031)
Over 18 to 24, incl.	1/8 (0.125)	1/32 (0.031)

12 to 16 ft, or in double random lengths with a minimum average of 35 ft and a minimum length of 22 ft with 5 per cent 16 to 22 ft.

Ends

16. Unless otherwise specified, pipe shall be furnished with plain ends. All burrs at the ends of the pipe shall be removed.

Finish

17. (*a*) The finished pipe shall be reasonably straight and free from injurious defects. At the discretion of the inspector representing the purchaser, finished pipe shall be subject to rejection if surface defects acceptable under Paragraph (*c*) are not scattered, but appear over a large area in excess of what is considered a workmanlike finish.

(*b*) *Depth of Injurious Defects.*—All defects shall be explored for depth. When the depth is in excess of 12½ per cent of the nominal wall thickness or encroaches on the minimum wall thickness such defects shall be considered injurious.

(*c*) *Machining or Grinding Defects Not Classified as Injurious.*—Surface defects not classified as injurious shall be treated as follows:

(*1*) Pipe showing scabs, seams, laps, tears, or slivers not deeper than 5 per cent of the nominal wall thickness need not have these defects removed. If deeper than 5 per cent, such defects shall be removed by machining or grinding.

(*2*) Mechanical marks or abrasions[6] and pits shall be acceptable without grinding or machining provided the depth does not exceed the limitations set forth in Paragraph (*b*) and if not deeper than 1/16 in. If such defects are deeper than 1/16 in. but not deeper than 12½ per cent of the nominal wall thickness, they shall be removed by grinding or machining to sound metal.

(*3*) When defects have been removed by grinding or machining, the outside diameter at the point of grinding or machining may be reduced by the amount so removed. Should it be impracticable to secure a direct measurement, the wall thickness at the point of grinding, or at a defect not required to be removed, shall be determined by deducting the amount removed in grinding or the depth of the defect, from the minimum measured wall thickness at the ends of the pipe, and the remainder shall not be less than 87.5 per cent of the nominal wall thickness.

(*4*) Machining or grinding shall follow the mill's inspection of the pipe as rolled and shall be followed by supplementary visual inspection.

(*d*) *Repair by Welding.*—Repair of injurious defects shall be permitted only subject to the approval of the purchaser. Welding of injurious defects in no case shall be permitted when the depth of defect exceeds 33⅓ per cent of the nominal pipe wall thickness or the length of repair exceeds 25 per cent of the nominal diameter of the pipe. Defects shall be thoroughly chipped or ground out before welding. Each length of repaired pipe shall be retested hydrostatically in accordance with Section 9.

[6] Marks and abrasions are defined as cable marks, dinges, guide marks, roll marks, ball scratches, scores, die marks, etc.

Marking

18. (*a*) Each length of pipe manufactured in accordance with these specifications shall be legibly marked, either by stencilling, stamping, or rolling, with the manufacturer's private identifying mark, together with the designation A 106-A (or B or C, depending on the grade of steel used), the hydrostatic test pressure, and an additional S if the pipe conforms in any case to the supplementary requirements specified in Paragraphs S1 to S6. The length and schedule number of the pipe also shall be included. Marking shall begin approximately 12 in. from one end of each length. On pipe sizes larger than 4 in., the weight shall be given. On small diameter pipe which is bundled, the above information may be legibly stamped on a metal tag securely attached to each bundle. When pipe marked as specified in this section is rejected, the designation A 106 shall be canceled.

(*b*) When it is specified that certain requirements of these specifications are to be completed by the purchaser upon receipt of the material, the manufacturer shall indicate that all requirements of the specifications have not been completed by a letter X, Y, or Z immediately following the specification number. This letter may be removed after completion of all requirements in accordance with these specifications. An explanation of specification requirements to be completed is provided in Section 19(*b*).

Inspection

19. (*a*) The inspector representing the purchaser shall have free entry, at all times while work on the contract of the purchaser is being performed, to all parts of the manufacturer's works that concern the manufacture of the material ordered. The manufacturer shall afford the inspector, without charge, all reasonable facilities to satisfy him that the material is being furnished in accordance with these specifications. All tests and inspection shall be made at the place of manufacture prior to shipment and at the manufacturer's expense, unless otherwise specified, and shall be so conducted as not to interfere unnecessarily with the operation of the works.

(*b*) *Certification.*—The certificate or report accomplished by the manufacturer shall include a statement of explanation for the letter added to the specification number (see Section 18(*b*)), when all the requirements of these specifications have not been completed. The purchaser must certify that all requirements of the specifications have been completed before removal of the letter X, Y, or Z.

Rejection

20. Each length of pipe that develops injurious defects during shop working or application operations will be rejected, and the manufacturer shall be notified. No rejections under these or any other specifications shall be marked as specified in Section 18 for sale under these specifications except where such pipe fails to comply with the weight requirements alone, in which case it may be sold under the weight specifications with which it does comply.

SUPPLEMENTARY REQUIREMENTS FOR SEAMLESS PIPE 8 IN. AND OVER IN NOMINAL DIAMETER FOR USE IN CENTRAL STATIONS AT PRESSURES OF 400 PSI AND OVER AND HIGH TEMPERATURES OR OTHER APPLICATIONS WHERE A SUPERIOR GRADE OF PIPE IS REQUIRED

S1. These requirements shall not be considered unless specified in the order, in which event the supplementary tests specified in Paragraphs S2 to S6 shall be made at the mill at the purchaser's expense and witnessed by his inspector before shipment of the material. If these tests are required for smaller size pipe, they shall be made the subject of agreement between the manufacturer and the purchaser.

Check Analysis

S2. Check analysis may be made on any length of pipe. Individual lengths failing to conform to the chemical requirements prescribed in Table I shall be rejected.

Transverse Tension Test

S3. Transverse tension tests may be made on specimens from both ends of each length of pipe. If the specimen from either end of any length fails to conform to the mechanical properties prescribed in Table II, that length shall be rejected.

Flattening Test

S4. The flattening tests specified in Section 8 may be made on specimens from both ends of each length of pipe. Crop ends may be used. If the specimen from either end of any length fails to conform to the specified requirements, that length shall be rejected.

Finish and Metal Structure

S5. The steel shall have a homogeneous structure as shown by the etching test described in Paragraph S6.

Etching Tests

S6. Etching tests may be made on sections from any pipe, and shall show sound and reasonably uniform material, free from injurious laminations, cracks, and similar objectionable defects. If the specimen from any length shows objectionable defects, that length may be rejected.

EXPLANATORY NOTES

NOTE 1.—For allowable working stresses, see the Code for Pressure Piping (ASA No.: B31.1—1955) of the American Standards Association, and the Boiler Construction Code of the American Society of Mechanical Engineers.

Consideration should be given to possible graphitization of the material at the higher temperatures at which it may be used.

NOTE 2.—Grade A rather than grade B pipe should be used for close coiling, cold bending, or for forge welding. The purpose for which the pipe is to be used should be stated in the order. This note is not intended to prohibit the cold bending of grade B seamless pipe.

NOTE 3.—Table III is the recommendation of the Sectional Committee on Standardization of Dimensions and Material of Wrought-Iron and Wrought-Steel Pipe and Tubing, functioning under the procedure of the American Standards Association, ASA Project No.: B36, except for the omission of all 30-in. sizes.

APPENDIX I

TABLE V.—CALCULATED "H" VALUES FOR SEAMLESS PIPE.

Size (Nominal Inside Diameter), in.	Outside Diameter, in.	Wall Thickness, in.	Schedule Number	Distance, in Inches, Between Plates "H", by Formula: $H = \frac{(1+e)t}{e+t/d}$ Grade A	Distance, in Inches, Between Plates "H", by Formula: $H = \frac{(1+e)t}{e+t/d}$ Grades B & C
2½	2.875	0.203	40	1.456	1.545
		0.276	80	1.694	1.779
		0.375	160	1.925	2.002
3	3.500	0.216	40	1.646	1.755
		0.300	80	1.955	2.062
		0.438	160	2.306	2.398
3½	4.000	0.226	40	1.788	1.912
		0.318	80	2.153	2.276
4	4.500	0.237	40	1.929	2.067
		0.337	80	2.350	2.489
		0.438	120	2.687	2.818
		0.531	160	2.896	3.022
5	5.563	0.258	40	2.205	2.372
		0.375	80	2.747	2.920
		0.500	120	3.179	3.346
		0.625	160	3.509	3.667
6	6.625	0.280	40	2.473	2.669
		0.432	80	3.213	3.419
		0.562	120	3.682	3.884
		0.718	160	4.116	4.307
8	8.625	0.250	20	2.477	2.702
		0.277	30	2.668	2.902
		0.322	40	2.964	3.210
		0.406	60	3.451	3.711
		0.500	80	3.914	4.181
		0.593	100	4.305	4.573
		0.718	120	4.750	5.013
		0.812	140	5.036	5.293
		0.906	160	5.288	5.538
10	10.750	0.250	20	2.615	2.868
		0.307	30	3.054	3.333
		0.365	40	3.459	3.757
		0.500	60	4.268	4.592
		0.593	80	4.738	5.070
		0.718	100	5.320	5.621
		0.843	120	5.747	6.077
		1.000	140	6.242	6.564
		1.125	160	6.580	6.892
12	12.750	0.250	20	2.711	2.985
		0.330	30	3.366	3.683
		0.406	40	3.921	4.266
		0.562	60	4.892	5.271
		0.687	80	5.542	5.934
		0.843	100	6.231	6.627
		1.000	120	6.817	7.209
		1.125	140	7.222	7.607
		1.312	160	7.747	8.119
14 OD	14.000	0.250	10	2.759	3.045
		0.312	20	3.204	3.617
		0.375	30	3.792	4.146
		0.438	40	4.669	5.125
		0.593	60	5.234	5.647
		0.750	80	6.064	6.494
		0.937	100	6.887	7.322
		1.093	120	7.479	7.902
		1.250	140	7.974	8.397
		1.406	160	8.416	8.827
16 OD	16.000	0.250	10	2.824	3.124
		0.312	20	3.387	3.730
		0.375	30	3.915	4.294
		0.500	40	4.854	5.284
		0.656	60	5.855	6.324
		0.843	80	6.861	7.352
		1.031	100	7.709	8.206
		1.218	120	8.426	8.919
		1.438	140	9.141	9.625
		1.593	160	9.579	10.050
18 OD	18.000	0.250	10	2.876	3.189
		0.312	20	3.402	3.823
		0.438	30	4.535	4.963
		0.562	40	5.457	5.941
		0.750	60	6.656	7.185
		0.937	80	7.663	8.214
		1.156	100	8.657	9.216
		1.375	120	9.495	10.043
		1.562	140	10.115	10.660
		1.781	160	10.665	11.198
20 OD	20.000	0.250	10	2.919	3.242
		0.375	20	4.101	4.521
		0.500	30	5.143	5.632
		0.593	40	5.841	6.367
		0.812	60	7.272	7.856
		1.031	80	8.464	0.976
		1.281	100	9.601	10.221
		1.500	120	10.452	11.069
		1.750	140	11.284	11.889
		1.968	160	11.913	12.504
24 OD	24.000	0.250	10	2.986	3.326
		0.375	20	4.236	4.686
		0.562	30	5.869	6.437
		0.687	40	6.831	7.454
		0.968	60	8.690	9.390
		1.218	80	10.061	10.793
		1.531	100	11.449	12.244
		1.812	120	12.585	13.332
		2.062	140	13.424	14.150
		2.343	160	14.248	14.958

APPENDIX II

TABLE VI.—TABLE OF MINIMUM WALL THICKNESSES ON INSPECTION FOR NOMINAL (AVERAGE) PIPE WALL THICKNESSES.

NOTE 1.—The following equation, upon which this table is based, may be applied to calculate minimum wall thickness from nominal (average) wall thickness:

$$t_n \times 0.875 = t_m$$

where:

t_n = nominal (average) wall thickness in inches, and

t_m = minimum wall thickness in inches.

The wall thickness is expressed to three decimal places, the fourth decimal place being carried forward or dropped, in accordance with the Recommended Practices for Designating Significant Places in Specified Limiting Values (ASTM Designation E 29).

NOTE 2.—This table is a master table covering wall thicknesses available in the purchase of different classifications of pipe, but it is not meant to imply that all of the walls listed therein are obtainable under this specification.

Nominal (Average) Thickness (t_n), in.	Minimum Thickness on Inspection (t_m), in.	Nominal (Average) Thickness (t_n), in.	Minimum Thickness on Inspection (t_m), in.	Nominal (Average) Thickness (t_n), in.	Minimum Thickness on Inspection (t_m), in.
0.068	0.060	0.294	0.257	0.750	0.656
0.088	0.077	0.300	0.262	0.812	0.710
0.091	0.080	0.307	0.269	0.843	0.738
0.095	0.083	0.308	0.270	0.864	0.756
0.113	0.099	0.312	0.273	0.875	0.766
0.119	0.104	0.318	0.278	0.906	0.793
0.125	0.109	0.322	0.282	0.937	0.820
0.126	0.110	0.330	0.289	0.968	0.847
0.133	0.116	0.337	0.295	1.000	0.875
0.140	0.122	0.343	0.300	1.031	0.902
0.145	0.127	0.344	0.301	1.062	0.929
0.147	0.129	0.358	0.313	1.093	0.956
0.154	0.135	0.365	0.319	1.125	0.984
0.156	0.136	0.375	0.328	1.156	1.012
0.179	0.157	0.382	0.334	1.218	1.066
0.187	0.164	0.400	0.350	1.250	1.094
0.188	0.164	0.406	0.355	1.281	1.121
0.191	0.167	0.432	0.378	1.312	1.148
0.200	0.175	0.436	0.382	1.343	1.175
0.203	0.178	0.437	0.382	1.375	1.203
0.216	0.189	0.438	0.383	1.406	1.230
0.218	0.191	0.500	0.438	1.438	1.258
0.219	0.192	0.531	0.465	1.500	1.312
0.226	0.198	0.552	0.483	1.531	1.340
0.237	0.207	0.562	0.492	1.562	1.367
0.250	0.219	0.593	0.519	1.593	1.394
0.258	0.226	0.600	0.525	1.750	1.531
0.276	0.242	0.625	0.547	1.781	1.558
0.277	0.242	0.656	0.573	1.812	1.586
0.279	0.244	0.674	0.590	1.968	1.722
0.280	0.245	0.687	0.601	2.062	1.804
0.281	0.246	0.718	0.629	2.343	2.050

SPECIFICATION FOR STRUCTURAL STEEL FOR LOCOMOTIVES AND CARS

SA-113

(IDENTICAL WTH ASTM SPECIFICATION A 113-58 EXCEPT THAT GRADES A AND B HAVE BEEN DELETED)

Scope

1. This specification covers carbon-steel plates (except boiler and firebox plates) intended primarily for use in locomotive and car construction.

General Requirements for Delivery

2. Material furnished under this specification shall conform to the applicable requirements of the current edition of the Specification for General Requirements for Delivery of Rolled Steel Plates, Shapes, Sheet Piling, and Bars for Structural Use (ASTM Designation: A 6).

Process

3. The steel shall be made by one or more of the following processes: open hearth, basic oxygen, or electric furnace.

Chemical Composition

4. When subjected to the ladle and check analyses, respectively, required by the provisions of Specification A 6, the steel shall conform to the requirements as to chemical composition prescribed in Table I.

Tensile Properties

5. (*a*) The material as represented by the test specimens shall conform to the requirements as to tensile properties prescribed in Table II.

TABLE I.—CHEMICAL REQUIREMENTS.

	Ladle Analysis	Check Analysis
Phosphorus, max, per cent:		
Acid	0.06	0.075
Basic	0.04	0.05
Sulfur, max, per cent	0.05	0.063
Copper, when copper steel is specified, min, per cent	0.20	0.18
Carbon, max, per cent	0.40	0.44
Phosphorus, max, per cent:		
Acid	0.06	0.075
Basic	0.04	0.05
Sulfur, max, per cent	0.05	0.063
Silicon, min, per cent	0.20	0.18
Copper, when copper steel is specified, min, per cent	0.20	0.18

TABLE II.—TENSILE REQUIREMENTS.

	Grade C, Cold Pressing Plates
Tensile strength, psi	48 000 to 58 000
Yield point, min, psi	26 000
Elongation in 8 in., min, per cent	26[b]
Elongation in 2 in., min, per cent	...

[b] See Section 6(*a*) and (*d*).

(*b*) For material under $\frac{5}{16}$ in. in thickness, a deduction from the percentage of elongation in 8 in. prescribed in Table II of 1.25 per cent shall be made for each decrease of $\frac{1}{32}$ in. of the specified thickness below $\frac{5}{16}$ in.

(*c*) For material over $\frac{3}{4}$ in. in thickness, a deduction from the percentage of elongation in 8 in. prescribed in Table II of 0.50 per cent shall be made for each increase of $\frac{1}{8}$ in. of the specified thickness above $\frac{3}{4}$ in. This deduction shall not exceed 3 per cent.

Bending Properties

6. Bend-test specimens for plates for cold pressing, grade C, shall stand being bent cold through 180 deg flat on themselves without cracking on the outside of the bent portion.

Number of Tests

7. Two tension and two bend tests shall be made from each heat, unless the finished material from a heat is less than 30 tons, when one tension test and one bend test will be sufficient. If, however, material from one heat differs $\frac{3}{8}$ in. or more in thickness, one tension test and one bend test shall be made from both the thickest and the thinnest material rolled, regardless of the weight represented.

SPECIFICATION FOR OPEN-HEARTH IRON PLATES OF FLANGE QUALITY

SA-129

(IDENTICAL WITH ASTM SPECIFICATION A 129-56)

Scope

1. (*a*) This specification covers three types of open-hearth iron plates of flange quality.

(*b*) The maximum thickness of plates to be ordered under this specification shall be 2 in.

General Requirements for Delivery

2. Material furnished under this specification shall conform to the applicable requirements of the current edition of the Tentative Specification for General Requirements for Delivery of Rolled Steel Plates of Flange and Firebox Qualities (ASTM Designation: A 20).

Process

3. The iron shall be made by the basic open-hearth process.

Chemical Composition

4. The iron shall conform to the requirements as to chemical composition prescribed in Table I.

Tensile Properties

5. (*a*) The material as represented by the tension test specimens shall conform to the requirements as to tensile properties prescribed in Table II.

(*b*) For material under $\frac{5}{16}$ in. in thickness, a deduction from the percentage of elongation in 8 in. specified in Table II of 1.25 per cent shall be made for each decrease of $\frac{1}{32}$ in. of the specified thickness below $\frac{5}{16}$ in.

(*c*) For material over $\frac{3}{4}$ in. in thickness, a deduction from the percentage of elongation in 8 in. specified in Table II of 0.5 per cent shall be made for each increase of $\frac{1}{8}$ in. of the specified thickness above $\frac{3}{4}$ in. This deduction shall not exceed 3 per cent.

Bending Properties

6. The bend test specimen shall stand being bent cold through 180 deg. without cracking on the outside of the bent portion, as follows: for material 1 in. or under in thickness, flat on itself; and for material over 1 in., in thickness, to an inside diameter which is equal to the thickness.

Test Specimens

7. (*a*) Test specimens shall be prepared for testing from material in its rolled condition.

(*b*) When so specified in the purchase order with the mill, test specimens representing the plates shall be stress-relieved by gradually and uniformly heating them to a temperature between 1100 and 1200 F. (or a temperature range otherwise agreed upon between the manufacturer and the fabricator), holding at temperature for at least 1 hr. per inch of thickness and cooling in still atmosphere to a temperature not exceeding 600 F.

Number of Tests

8. One tension test and one bend test shall be made from each plate as rolled.

NOTE.—The term "plate as rolled" used here refers to the unit plate rolled from a slab or directly from an ingot in its relation to the location and number of specimens; not to its condition.

TABLE I.—CHEMICAL REQUIREMENTS.

	Type A		Type B		Type C	
	Ladle Analysis	Check Analysis	Ladle Analysis	Check Analysis	Ladle Analysis	Check Analysis
Phosphorus, max., per cent	0.015	0.015	0.015	0.015	0.015	0.015
Sulfur, max., per cent	0.04	0.05	0.04	0.05	0.04	0.05
Total of the metalloids: carbon, manganese, phosphorus, sulfur, and silicon, max., per cent	0.10	0.14	0.25	0.29	0.25	0.29
Copper, min., per cent	...	...	0.40	0.38	0.20	0.18
Molybdenum, min., per cent	...	...	0.05	0.05	...	...

TABLE II.—TENSILE REQUIREMENTS.

	Type A	Type B	Type C
Tensile strength, min., psi	40 000	44 000	42 000
Yield point, min., psi	22 000	27 000	23 000
Elongation in 8 in., min., per cent	20[a]	25[a]	22[a]
Elongation in 2 in., min., per cent	23	28	25

[a] See Sections 5 (*b*) and (*c*)

SPECIFICATION FOR ELECTRIC-RESISTANCE-WELDED STEEL PIPE

SA-135

(IDENTICAL WITH ASTM SPECIFICATION A 135-61T)

Scope

1. These specifications cover two grades of electric-resistance-welded steel pipe 30 in. and under in diameter with nominal (average) walls. The pipe is intended for conveying liquid, gas, or vapor; and only grade A is adapted for flanging and bending.[3] The suitability of pipe for various purposes is somewhat dependent upon its dimensions, properties, and conditions of service, so that the purpose for which the pipe is intended should be stated in the order.

Process

2. The steel shall be made by one or more of the following processes: open-hearth, basic oxygen, or electric-furnace.

Chemical Composition

3. The steel shall conform to the following requirements as to chemical composition:

Phosphorus, max, per cent	0.050
Sulfur, max, per cent	0.060

Ladle Analysis

4. An analysis of each heat of steel shall be made by the manufacturer to determine the percentages of the elements specified in Section 3. When requested by the purchaser, the chemical composition thus determined shall be reported to the purchaser or his representative, and shall conform to the requirements specified in Section 3.

Check Analysis

5. (*a*) An analysis may be made by the purchaser on samples of pipe selected at random and shall conform to the requirements specified in Section 3. Samples for chemical analysis, except for spectrochemical analysis, shall be taken in accordance with the Method of Sampling Steel, Cast Iron, Open-Hearth Iron, and Wrought Iron for Determination of Chemical Composition (ASTM Designation: E 59). The number of samples shall be determined as follows:

Pipe Size, In.	Number of Samples Selected
Under 6	2 from each lot of 400 pipes or fraction thereof
6 to 20, incl.	2 from each lot of 200 pipes or fraction thereof
Over 20 to 30, incl.	2 from each lot of 100 pipes or fraction thereof

(*b*) *Retests.*—If the analysis of either length of pipe or length of skelp does not conform to the requirements specified in Section 3, analyses of two additional lengths from the same lot shall be made, each of which shall conform to the requirements specified.

Tensile Properties

6. (*a*) The material shall conform to the requirements as to tensile properties prescribed in Table I.

(*b*) The yield point shall be determined by the drop of the beam, by the halt in the gage of the testing machine, by the use of dividers, or by other approved methods. When a definite yield point is not exhibited, the yield strength corresponding to a permanent offset of 0.2 per cent of the gage length of the specimen, or to a total extension of 0.5 per cent of the gage length under load shall be determined.

(*c*) The test specimen taken across the weld shall show a tensile strength not less than the minimum tensile strength specified for the grade of pipe ordered. This test will not be required for pipe under 6 in. in outside diameter.

Flattening Test

7. (*a*) A specimen at least 4 in. in length shall be flattened cold between parallel plates in three steps with the weld located either zero or 90 deg from the line of direction of force as required in Paragraph (*b*). During the first step, which is a test for ductility of the weld, no cracks or breaks on the inside or outside surfaces shall occur until the distance between the plates is less than two thirds of the original outside diameter of the pipe. As a second step, the flattening shall be continued. During the second step, which is a test for ductility exclusive of the weld, no cracks or breaks on the inside or outside surfaces shall occur until the distance between the plates is less than one third of the original outside diameter of the pipe but is not less than five times the wall thickness of the pipe. During the third step, which is a test for soundness, the flattening shall be continued until the specimen breaks or the opposite walls of the pipe meet. Evidence of laminated or unsound material or of incomplete weld that is revealed during the entire flattening test shall be cause for rejection.

(*b*) For pipe produced in single lengths, the flattening test specified in Paragraph (*a*) shall be made on both crop ends cut from each length of pipe. The tests from each end shall he made alternately with the weld at 0 deg and at 90 deg from the line of direction of force. For pipe produced in multiple lengths, the flattening test shall be made on crop ends representing the front and back of each coil with the weld at 90 deg from the line of direction of force, and on two intermediate rings representing each coil with the weld 0 deg from the line of direction of force.

(*c*) Surface imperfections in the test specimen before flattening, but revealed during the first step of the flattening test, shall be judged in accordance with the finish requirements in Section 16.

(*d*) Superficial ruptures as a result of surface imperfections shall not be cause for rejection.

Hydrostatic Test

8. (*a*) Each length of pipe shall be tested at the mill to a hydrostatic pressure calculated from the following formula, provided that in no case shall the test pressure exceed 2500 psi:

$$P = \frac{2St}{D}$$

where:

P = minimum hydrostatic test pressure in pounds per square inch,

S = allowable fiber stress (16,000 to 18,000 psi for grade A and 20,000 to 22,000 psi for grade B, but in no case shall the stress produced exceed 80 per cent of the specified yield point),

t = wall thickness in inches, and

D = outside diameter in inches.

(*b*) The hydrostatic pressure shall be maintained for not less than 5 sec and, for pipe with wall thicknesses greater than 0.154 in., the pipe shall be jarred near both ends with a 2-lb steel hammer or its equivalent.

Nondestructive Electric Test

9. As an alternate to the hydrostatic test, as applied to schedule 10 in $\frac{3}{4}$ to 4 in., nominal pipe size, and when accepted by the purchaser, each pipe shall be tested at the mill by passing it through a nondestructive tester capable of detecting any defect that completely penetrates the pipe wall or any defect equal to or greater than those shown in Table II. Such tests shall be made on the welded seam, and the adjacent metal affected thereby, or on the entire cross-section of the pipe, at the option of the manufacturer.

Test Specimens and Methods of Testing

10. (*a*) The test specimens and the tests required by these specifications shall conform to those described in the Methods and Definitions for the Mechanical Testing of Steel Products (ASTM Designation: A 370).

(*b*) The longitudinal tension test specimen shall be taken from the end of the pipe, or by agreement between the manufacturer and the purchaser may be taken from the skelp, at a point approximately 90 deg from the weld, and shall not be flattened between gage marks. The sides of each specimen shall be parallel between gage marks.

(*c*) Transverse weld test specimens from electric welded pipe shall be taken with the weld at the center of the specimen. All transverse test specimens shall be approximately $1\frac{1}{2}$ in. wide in the gage length and shall represent the full wall thickness of the pipe from which the specimen was cut.

(*d*) All specimens shall be tested at room temperature.

Number of Tests

11. (*a*) One longitudinal tension test shall be made on one length[5] from each lot of 400 lengths or fraction thereof of each size under 6 in., and one longitudinal and one transverse tension test on one length from each lot of 200 lengths or fraction thereof of each size 6 to 20 in., and on one length from each lot of 100 lengths or fraction thereof of each size over 20 to 30 in. When taken from the skelp, the number of tests shall be determined in the same manner as when taken from the finished pipe.

(*b*) If any test specimen shows defective machining or develops flaws not associated with the quality of the steel or the welding, it may be discarded and another specimen substituted.

(*c*) If the percentage of elongation of any tension test specimen is less than

[3] This provision is not intended to prohibit the cold bending of grade B pipe.

TABLE I.—TENSILE REQUIREMENTS.

	Grade A	Grade B
Tensile strength, min, psi	48 000	60 000
Yield point, min, psi	30 000	35 000
Elongation in 2 in., min, per cent:		
Basic minimum elongation for walls $\frac{5}{16}$ in. and over in thickness, longitudinal strip tests, and for all small sizes tested in full section	35	30
For longitudinal strip tests, the width of the gage section shall be $1\frac{1}{2}$ in. and a deduction for each $\frac{1}{32}$-in. decrease in wall thickness below $\frac{5}{16}$ in. from the basic minimum elongation of the following percentage	1.75[a]	1.50[a]

[a] The following table gives computed minimum values:

Wall Thickness, in.	Elongation in 2 in., min, per cent	
	Grade A	Grade B
$\frac{5}{16}$ (0.312)	35.00	30.00
$\frac{9}{32}$ (0.281)	33.25	28.50
$\frac{1}{4}$ (0.250)	31.50	27.00
$\frac{7}{32}$ (0.219)	29.75	25.50
$\frac{3}{16}$ (0.188)	28.00	24.00
$\frac{5}{32}$ (0.156)	26.25	22.50
$\frac{1}{8}$ (0.125)	24.50	21.00
$\frac{3}{32}$ (0.094)	22.75	19.50
$\frac{1}{16}$ (0.062)	21.00	18.00

NOTE.—The above table gives the computed minimum elongation values for each $\frac{1}{32}$-in. decrease in wall thickness. Where the wall thickness lies between two values shown above, the minimum elongation value shall be determined by the following equation:

Grade	Equation
A	$E = 56t + 17.50$
B	$E = 48t + 15.00$

where:

E = elongation in 2 in. in per cent, and

t = actual thickness of specimen, in inches.

TABLE II.—DIMENSIONS OF MAXIMUM ALLOWABLE DEFECTS IN PIPE WALLS

Wall Thickness[a]		Minor Dimension (Least Dimension of the Defect), Length, or Depth	Defective Area (Length × Radial Depth), Sq in.
Inches	BWG		
0.035	20	0.006 in.	0.0025
0.049	18	0.006 in.	0.0030
0.065	16	12½ per cent of wall	0.0030
0.083	14	12½ per cent of wall	0.0040
0.095	13	12½ per cent of wall	0.0040
0.109 and over	12 and heavier	12½ per cent of wall	0.0050

[a] For intermediate wall thicknesses, the next lower wall thickness shown in the table shall apply.

that specified in Section 6(*a*) and any part of the fracture is more than ¾ in. from the center of the gage length of a 2-in. specimen, as indicated by scribe scratches marked on the specimen before testing, the specimen may be discarded and another substituted.

(*d*) The flattening test specified in Section 7 shall be made on both crop ends cut from each length of pipe. When pipe is produced in multiple lengths, flattening tests are required on the crop ends from the front and back ends of each coil and on two intermediate rings representing each coil.

(*e*) Each length of pipe shall be subjected to the hydrostatic test specified in Section 8.

Retests

12. (*a*) If the results of the tension tests of any lot do not conform to the requirements specified in Section 6, retests of two additional lengths from the same lot shall be made, each of which shall conform to the requirements specified.

(*b*) If any section of the pipe fails to comply with the requirements of Section 7(*a*), for pipe produced in single lengths other sections may be cut from the same end of the same length until satisfactory tests are obtained, except that the finished pipe shall not be shorter than 80 per cent of its length after the initial cropping; otherwise, the length shall be rejected. For pipe produced in multiple lengths, retests may be cut from each end of each individual length in the multiple; such tests shall be made with the weld alternately 0 deg and 90 deg from the line of direction of force.

[5] Length is defined as the length as ordered, except that in the case of orders for cut lengths shorter than single random, the term lot shall apply to the lengths as rolled, prior to cutting to the required short lengths.

Permissible Variations in Weight and Dimensions

13. (*a*) *Weight.*—The weight of any length of pipe shall not vary more than 3.5 per cent under or 10 per cent over that specified, but the carload weight shall be not more than 1.75 per cent under the nominal weight. The weight of pipe furnished to schedule 10 shall not vary more than ±10 per cent from that prescribed in Appendix II.

NOTE 1.—A system of standard pipe sizes has been approved by the American Standards Association as American Standard for Wrought Steel and Wrought Iron Pipe (ASA No.: B36.10—1959). Copies of this American Standard are available from The American Society of Mechanical Engineers, 345 E. 47th St., New York 17, N. Y.

(*b*) *Diameter.*—The outside diameter shall not vary more than ±1 per cent from the nominal size specified.

(*c*) *Thickness.*—The minimum wall thickness at any point shall be not more than 12.5 per cent under the nominal wall thickness specified.

NOTE 2.—The minimum wall thickness on inspection is shown in Table III (Appendix I).

Lengths

14. Unless otherwise specified, pipe shall be furnished in lengths averaging 38 ft or over, with a minimum length of 20 ft, but not more than 5 per cent may be under 32 ft. Jointers made by welding are permissible. When threaded pipe is ordered, jointers shall be made by threading and shall not exceed 5 per cent of the order. Pipe furnished to schedule 10 shall be in a specified length between 16 and 22 ft with shorts down to 8 ft. Short lengths shall not exceed 10 per cent of the footage.

Workmanship

15. (*a*) *Schedule 10 Pipe.*—Pipe furnished to schedule 10 shall be plain end only. All inside and outside cutting burrs shall be removed. This generally involves breaking the corners.

(*b*) *Ends, Plain End Pipe.*—Unless otherwise specified, plain end pipe for use with the Dresser or Dayton type coupling shall be reamed both outside and inside sufficiently to remove all burrs. Plain end pipe for welding shall be beveled on the outside to an angle of 35 deg with a tolerance of ±2.5 deg and with a width of flat at the end of the pipe of $\frac{1}{16} \pm \frac{1}{32}$ in. When material is ordered beveled to any other than a 35-deg angle, it should be understood that the angle is to be measured from a line drawn perpendicular to the axis of the pipe. This means that a greater amount of material is removed with a 60-deg angle than with a 35-deg angle. Pipe shall be sufficiently free from indentations, projections, or roll marks for a distance of 8 in. from the end of the pipe to make a tight joint with the rubber gasket type of coupling. All plain end pipe intended for Dresser or Dayton type joints or for welding, sizes 10¾ in. and smaller in outside diameter, shall be not more than $\frac{1}{32}$ in. smaller than the nominal outside diameter for a distance of 8 in. from the end of the pipe and shall permit the passing for a distance of 8 in. of a ring gage which has a bore $\frac{1}{16}$ in. larger than the nominal outside diameter of the pipe. Sizes larger than 10¾ in. in outside diameter shall be not more than $\frac{1}{32}$ in. smaller than the nominal outside diameter for a distance of 8 in. from the end of the pipe and shall permit the passing for a distance of 8 in. of a ring gage which has a bore $\frac{3}{32}$ in. larger than the nominal outside diameter of the pipe.

(*b*) *Ends, Threaded Pipe.*—Each end of threaded pipe shall be reamed to remove all burrs. All threads shall be in accordance with the American Standard Pipe Threads[6] and cut so as to make a tight joint when the pipe is tested at the mill to the specified internal hydrostatic pressure. The variation from the standard, when tested with the standard working gage, shall not exceed one and one-half turns either way. Pipe shall not be rounded-out by hammering in order to get a full thread. There shall be not more than two black threads for ¾-in. taper among the perfect threads. Black threads should not be confused with imperfect threads, such as those torn, shaven, or broken.

(*c*) *Couplings.*—Each length of threaded pipe shall be provided with one coupling, the threads of which shall be in accordance with the American Standard for Pipe Threads.[6] Threads shall be cut so as to make a tight joint. Couplings may be of wrought iron or steel. Taper-tapped couplings shall be furnished on all weights of threaded pipe 2½ in. and larger.[7]

Finish

16. (*a*) The finished pipe shall be reasonably straight and free from injurious defects. Defects in excess of 12.5 per cent of the nominal wall thickness shall be considered injurious.

[6] A complete description of the American Standard Pipe Threads applicable to pipe, valves, and fittings is contained in the American Standard for Pipe Threads (ASA No.: B2.1—1960); also "Screw-Thread Standards for Federal Services, 1942," National Bureau of Standards *Handbook H28*, January, 1942, the pertinent data in both sources being identical.

[7] For sizes 2 in. and smaller, it is commercial practice to furnish straight-tapped couplings for standard-weight (Schedule 40) pipe and taper-tapped couplings for extra-strong (Schedule 80) and double-extra-strong pipe. If taper-tapped couplings are required for sizes 2 in. and smaller on standard weight (Schedule 40) pipe, line pipe in accordance with Specification 5L of the American Petroleum Institute should be ordered, thread lengths to be in accordance with the American Standard for Pipe Threads (ASA No.: B2.1—1960). The taper-tapped couplings provided on line pipe in those sizes may be used on mill-threaded standard weight pipe of the same size.

(*b*) *Repair by Welding.*—Injurious defects in the pipe wall, provided their depth does not exceed one-third the specified wall thickness, shall be repaired by electric welding. Defects in the welds such as sweats or leaks, unless otherwise specified, shall be repaired or the piece rejected at the option of the manufacturer. Repairs of this nature shall be made by completely removing the defect, cleaning the cavity, and then electric welding.

(*c*) All repaired pipe shall be retested hydrostatically in accordance with Section 8.

Marking

17. (*a*) Each length of pipe shall be legibly marked with appropriate symbols by stenciling, stamping, or rolling to show by whom manufactured, the grade of pipe, and that it conforms to these specifications.

(*b*) When it is specified that certain requirements of these specifications are to be completed by the purchaser upon receipt of the material, the manufacturer shall indicate that all requirements of the specifications have not been completed by a letter X, Y, or Z immediately following the specification number. This letter may be removed after completion of all requirements in accordance with these specifications. An explanation of specification requirements to be completed is provided in Section 19(*b*).

Protective Coating

18. After the pipe has been subjected to the hydrostatic test, and if required by the purchaser, it shall be thoroughly cleaned of all dirt, oil, grease, loose scale, and rust; then dried, and given a protective coating of the kind and in the manner specified by the purchaser. Pipe furnished to schedule 10 shall be normally shipped with a light coating of processing oil. If so specified, the pipe can be given a mill coating or a special coating.

Inspection

19. (*a*) The inspector representing the purchaser shall have free entry, at all times while work on the contract of the purchaser is being performed, to all parts of the manufacturer's works that concern the manufacture of the material ordered. The manufacturer shall afford the inspector, without charge, all reasonable facilities to satisfy him that the material is being furnished in accordance with these specifications. All tests (except check analysis) and inspection shall be made at the place of manufacture prior to shipment, unless otherwise specified, and shall be so conducted as not to interfere unnecessarily with the operation of the works.

(*b*) *Certification.*—The certificate or report accomplished by the manufacturer shall include a statement of explanation for the letter added to the specification number (see Section 17(*b*)), when all the requirements of these specifications have not been completed. The purchaser must certify that all requirements of the specifications have been completed before removal of the letter X, Y, or Z.

Rejection

20. Each length of pipe that develops injurious defects during shop working or application operations will be rejected, and the manufacturer shall be notified.

APPENDIX I

TABLE III.—TABLE OF MINIMUM WALL THICKNESSES ON INSPECTION FOR NOMINAL (AVERAGE) PIPE WALL THICKNESSES.

NOTE 1.—The following formula, upon which this table is based, may be applied to calculate minimum wall thickness from nominal (average) wall thickness:

$$t_n \times 0.875 = t_m$$

where:
t_n = nominal (average) wall thickness in inches, and
t_m = minimum wall thickness in inches.

The wall thickness is expressed to three decimal places, the fourth decimal place being carried forward or dropped, in accordance with the Recommended Practices for Designating Significant Places in Specified Limiting Values (ASTM Designation: E 29).

NOTE 2.—This table is a master table covering wall thicknesses available in the purchase of different classifications of pipe, but it is not meant to imply that all of the walls listed therein are obtainable under this specification.

Nominal (Average) Thickness (t_n), in.	Minimum Thickness on Inspection (t_m), in.	Nominal (Average) Thickness (t_n), in.	Minimum Thickness on Inspection (t_m), in.	Nominal (Average) Thickness (t_n), in.	Minimum Thickness on Inspection (t_m), in.
0.068	0.060	0.294	0.257	0.750	0.656
0.088	0.077	0.300	0.262	0.812	0.710
0.091	0.080	0.307	0.269	0.843	0.738
0.095	0.083	0.308	0.270	0.864	0.756
0.113	0.099	0.312	0.273	0.875	0.766
0.119	0.104	0.318	0.278	0.906	0.793
0.125	0.109	0.322	0.282	0.937	0.820
0.126	0.110	0.330	0.289	0.968	0.847
0.133	0.116	0.337	0.295	1.000	0.875
0.140	0.122	0.343	0.300	1.031	0.902
0.145	0.127	0.344	0.301	1.062	0.929
0.147	0.129	0.358	0.313	1.093	0.956
0.154	0.135	0.365	0.319	1.125	0.984
0.156	0.136	0.375	0.328	1.156	1.012
0.179	0.157	0.382	0.334	1.218	1.066
0.187	0.164	0.400	0.350	1.250	1.094
0.188	0.164	0.406	0.355	1.281	1.121
0.191	0.167	0.432	0.378	1.312	1.148
0.200	0.175	0.436	0.382	1.343	1.175
0.203	0.178	0.437	0.382	1.375	1.203
0.216	0.189	0.438	0.383	1.406	1.230
0.218	0.191	0.500	0.438	1.437	1 258
0.219	0.192	0.531	0.465	1.500	1.312
0.226	0.198	0.552	0.483	1.531	1.340
0.237	0.207	0.562	0.492	1.562	1.367
0.250	0.219	0.593	0.519	1.593	1.394
0.258	0.226	0.600	0.525	1.750	1.531
0.276	0.242	0.625	0.547	1.781	1.558
0.277	0.242	0.656	0.574	1.812	1.586
0.279	0.244	0.674	0.590	1.968	1.722
0.280	0.245	0.687	0.601	2.062	1.804
0.281	0.246	0.719	0.629	2.343	2.050

APPENDIX II

TABLE IV.—DIMENSIONS, NOMINAL WEIGHTS AND TEST PRESSURES FOR LIGHT WALL STEEL PIPE.

Nominal Pipe Size, in.	Outside Diameter, in.	Schedule 10			
		Nominal Wall Thickness, in.[a]	Weight, lb per ft	Test Pressure, psi	
				Grade A	Grade B
¾	1.050	0.083	0.86	2500	2500
1	1.315	0.109	1.40	2500	2500
1¼	1.660	0.109	1.81	2400	2500
1½	1.900	0.109	2.09	2100	2400
2	2.375	0.109	2.64	1700	1900
2½	2.875	0.120	3.52	1500	1700
3	3.500	0.120	4.32	1200	1400
3½	4.000	0.120	4.96	1000	1200
4	4.500	0.120	5.61	900	1100

[a] Corresponds to Schedule 10S as listed in the American Standard for Stainless Steel Pipe (ASA B36.19—1957). The test pressures are calculated by the following formula (but shall not exceed 2500 psi):

$$P = \frac{2St}{D}$$

where:
P = pressure in pounds per square inch,
S = fiber stress, 60 per cent of the specified minimum yield point,
t = thickness of wall in inches, and
D = outside diameter in inches.

SPECIFICATION FOR ELECTRIC-RESISTANCE-WELDED CARBON STEEL AND OPEN HEARTH IRON BOILER TUBES

SA-178

(IDENTICAL WITH ASTM SPECIFICATION A 178-61T)

Scope

1. (*a*) This specification covers electric-resistance-welded tubes made of carbon steel and open-hearth iron, and intended for use as boiler tubes, boiler flues, superheater flues, and safe ends.[1]

(*b*) This specification covers tubes ½ to 5 in., inclusive, in outside diameter and 0.035 to 0.320 in., inclusive, in minimum wall thickness.

(*c*) The purchaser shall specify in the order the outside diameter, minimum wall thickness, and grade desired. The inside diameter shall not be specified.

General Requirements

2. Material furnished under this specification shall conform to the applicable requirements of the current edition of the Specification for General Requirements for Carbon, Ferritic Alloy, and Austenitic Alloy Steel Tubes (ASTM Designation: A 450), unless otherwise provided herein.

Process

3. The steel or iron shall be made by one or more of the following processes: open-hearth, basic oxygen, or electric furnace.

Manufacture

4. Tubes shall be made by electric-resistance welding.

Heat Treatment

5. After welding all tubes shall be normalized at a temperature above the upper critical temperature.

Chemical Composition

6. The steel or iron shall conform to the requirements as to chemical composition prescribed in Table I.

[1] Type C tubes are not suitable for safe-ending by forge welding.

TABLE I.—CHEMICAL REQUIREMENTS.

	Grade A, Low-Carbon Steel	Grade B, Open-Hearth Iron	Grade C, Medium-Carbon Steel
Carbon, per cent	0.06 to 0.18	0.03 max	0.35 max
Manganese, per cent	0.27 to 0.63	0.03 max	0.80 max
Phosphorus, max, per cent	0.035	0.02	0.050
Sulfur, max, per cent	0.035	0.045	0.060

TABLE II.—TENSILE REQUIREMENTS.

Tensile strength, min, psi	60 000
Yield point, min, psi	37 000
Elongation in 2 in., min, per cent	30
For longitudinal strip tests the width of the gage section shall be 1 in, and a deduction for each 1/32-in. decrease in wall thickness below 5/16 in. from the basic minimum elongation of the following percentage	1.50[a]

[a] The following table gives the computed minimum values:

Wall Thickness, in.	Elongation in 2 in., min, per cent
5/16 (0.312)	30.00
9/32 (0.281)	28.50
1/4 (0.250)	27.00
7/32 (0.219)	25.50
3/16 (0.188)	24.00
5/32 (0.156)	22.50
1/8 (0.125)	21.00
3/32 (0.094)	19.50
1/16 (0.062)	18.00

NOTE.—The above table gives the computed minimum elongation values for each 1/32-in. decrease in wall thickness. Where the wall thickness lies between two values shown above, the minimum elongation value shall be determined by the following formula:

$$E = 48t + 15.00$$

where:
E = elongation in 2 in., in per cent, and,
t = actual thickness of specimen, in inches.

Check Analysis

7. (*a*) An analysis of two lengths of flat rolled stock or two tubes from each lot of 250 tubes or fraction thereof, and from each lot of 2000 ft or fraction thereof of safe-end material, may be made by the purchaser. If on flat rolled stock, samples shall be milled from the entire cross-section of the stock. The chemical composition thus determined shall conform to the requirements specified.

(*b*) If the analysis of one length of flat rolled stock or of either tube does not conform to the requirements specified, an analysis of two additional lengths of flat rolled stock or two additional tubes of the same lot shall be made, each of which shall conform to the requirements specified.

Crush Test

8. (*a*) When required by the purchaser, crushing tests shall be made on sections of tube 2½ in. in length which